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HUNGRY HORSE

HABITAT MITIGATION PROJECT

1993 ANNUAL REPORT

JOHN VORE • PATRICK R. MALTA

Montana Department of
Fish, Wildlife & Parks

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State: Montana

Project Title: Hungry Horse Elk Mitigation

Project No: 5142

Program Title: Northwest Montana Wildlife Habitat Enhancement

Period Coviered: 1 July 1992 - 1 October 1993

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EXECUTIVE SUMMARY

Beginning in September 1987, Bonneville Power Administration (BPA) funded an elk / mule deer winter range enhancement project adjacent to Hungry Horse Reservoir. Two elk / mule deer winter ranges adjacent to (east of) the reservoir were selected as having potential for enhancement. These were the Firefighter Mountain winter range (Firefighter), near the dam, and the Spotted Bear winter range (Spotted Bear) at the head of the reservoir. Firefighter was selected as providing the greatest opportunity for enhancement, due to limited quantity and quality of winter forage. A long-term enhancement plan was submitted to BPA in June 1990 (Casey and Malta 1990). That plan identified 71 habitat enhancement sites (67 at Firefighter, 4 at Spotted Bear). These included 13 sites in natural shrubfields, 6 sites where understory shrubs would be slashed, and 52 sites where some level of canopy removal would be used to create foraging areas. Enhancement activities are being funded through a trust fund agreement between Montana Fish, Wildlife & Parks (FWP) and BPA. This report summarizes project accomplishments through FY93 (July 1992 - October 1993).

A marked sample of approximately 45 elk has been used to monitor the wintering elk population at Firefighter. This winter range is inhabited by approximately 170±30 elk, most of which are resident animals. Two winter herd units have been identified which are likely to benefit from the habitat enhancement efforts. The 1993 population estimate was 106±20 elk. This low estimate was due to elk moving off the study area.

Calf and bull per 100 cow ratios were 30.2 and 15.6 respectively in 1993 and averaged 39.9 and 14.9 since 1989. Ratios among elk observed on summer/fall range were 50.5 calves and 35.0 bulls per 100 cows. Among 23 marked reproductive-age cows 52.2% were thought to have reared calves to 2-3 months of age. Based on observations of marked cows and differences between summer/fall and winter classifications, it is suggested that some cows may be losing their calves during summer. The high degree of variability in classifications ($\bar{x}$ coefficient of variation= 31% for calf and 62% for bulls per 100 cows) underscores the need for repeated sampling.

Mortality among all 45 marked elk on Firefighter was 20% during the report period. Sixty-seven percent of mortality was hunting related. Among cows, mortality was 19% with 63% of that hunting related. For 2 bulls known to be in the population mortality was 100%, all hunting-related.

Initial sightability models developed for Firefighter (Casey and Malta 1990c) were updated; sightability has averaged 22% over 6 winters. Sightability was strongly correlated with both group size (r^2=.7349, P=.0068) and canopy cover ($\log_{10}$ transformed data,

r^2=.994, P=.0000), but these relationships have not yet been combined into a predictive model. Data suggest that use of dense habitats by larger cow/calf groups plays an important role in the sightability of elk at Firefighter. Among groups of <7 elk, the relationship between group size and sightability was very strong (r^2=.992, P=.0000).

Indices of habitat use based on pellet-group data continue to show heavy use of natural openings as compared to forested habitats. Use of proposed enhancement sites (timber sale units) averaged well below random forested sites based on pellet-group data, indicating such sites are currently under-utilized by elk.

Data collection and analysis for the Spotted Bear winter range continues to be de-emphasized as Firefighter receives the focus of enhancement (and therefore monitoring and evaluation) efforts. We now estimate the wintering population at Spotted Bear to be over 1000 elk.

Vegetation monitoring efforts focused on treatment areas at Firefighter during 1991 and 1992. Browse-utilization transect data indicate preferred browse species are generally in poor condition in natural openings used by elk, and are present as a minor component of the shrub layer in timbered sites scheduled for treatment. Serviceberry, willow, redstem ceanothus, maple and rose continue to be preferred species where available. Preliminary analysis of vegetation response to treatment (slashing and burning) in 2 natural openings suggest that the relative abundance of plants did not change, while annual growth of leaders responded favorably by increasing an average of 123 and 358 mm. Indices of animal use were gave unclear results.

Investigation of elk food habits by microhistological analysis of feces showed that Pacific yew and Oregon grape were the most common winter food items eaten at Firefighter while Douglas fir and Western larch were the most common at Spotted Bear. Browse transects have shown willow, redstem ceanothus and rose to be favorite food items. Reasons for the apparent discrepency between the two methods are discussed.

In FY94 population monitoring will include continued efforts to increase the sample size of marked elk at Firefighter and restore an adequate sample size at Spotted Bear. An attempt will be made this winter to net gun elk from a helicopter to increase trapping effeciency, select study animals, and free time for other project activities. We will continue to collect data for mark/resighting estimates and to develop a sightability model. Approximately 40-50 pellet-group surveys will be conducted annually to monitor elk distribution and habitat use relative to enhancement sites. Monthly pellet samples will also be collected during winter months to determine seasonal food preferences at Firefighter. Twenty or more treatment and control sites will be sampled for

vegetation response on an annual basis using the USFS ECODATA Ocular and Short Nested Microplot methods. Additional browse transects will be conducted to monitor utilization and vigor of preferred browse species.

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INTRODUCTION

Portions of two important elk (Cervus elaphus) winter ranges totalling 8,749 acres were lost due to the construction of the Hungry Horse Dam hydroelectric facility (Casey et al. 1984). This habitat loss reduced the carrying capacity of these winter ranges by an estimated 175 elk, and the loss of 3,844 acres of upland shrub habitat on these winter ranges also lowered carrying capacity for mule deer (Odocoileus hemionus (Casey et al. 1984). The Hungry Horse wildlife mitigation plan (Bissell and Yde 1985) identified habitat enhancement on currently-occupied winter range as the most cost-efficient, easily implemented mitigation alternative available to address these large-scale losses of winter range. The Columbia Basin Fish and Wildlife Program, as amended in 1987, authorized BPA to fund winter range enhancement to meet an adjusted goal of 133 additional elk.

The advance design phase of the BPA-funded project was initiated in September 1987, and included detailed literature review, identification of enhancement areas, baseline (elk population and habitat) data collection, and preparation of 3-year (Casey et al. 1988) and 10-year (Casey and Malta 1990) implementation plans. Results of initial data collection were summarized in previous annual reports (Casey and Malta 1990, 1991, 1992). A site-specific habitat and population monitoring plan, which outlined our recommendations for evaluating the results of enhancement efforts against mitigation goals, was also prepared (Casey and Malta 1990b). This annual report summarizes results of the project efforts during the period 1 July 1992 - 1 October 1993.

The scope and objectives of this project directly address the management goals and concerns for elk and mule deer in FWP administrative Region 1 (Mussehl et al. 1986). Regional goals include improving elk habitat, increasing elk numbers, and seeking mitigation for habitat destroyed by federally-funded development projects. Public ownership of key habitats, consideration of habitats as land uses intensify, and provision of a diversity of hunting opportunities are all designated as important regional FWP concerns. Implementation of this mitigation effort has been identified specifically as an elk management strategy to be emphasized in our statewide elk management plan (MDFWP 1992). The project also directly complements big game winter range management efforts on the Hungry Horse and Spotted Bear Ranger Districts of the Flathead National Forest (USDA Forest Service 1985).

The primary responsibilities of the FWP project personnel have been to develop and implement the population and habitat monitoring effort. Enhancement activities are being conducted by personnel employed by or under contract with the Flathead

National Forest, either through separate contract(s) with BPA, or through the earnings of the wildlife mitigation trust fund.

Historical data summarized by Casey et al. (1984) indicated that elk populations have fluctuated between 1000-1500 in the valley of the South Fork Flathead River (South Fork) outside the wilderness, with the majority wintering on the Dry Parks portion of the Spotted Bear winter range (Biggins 1975). Prior to this study, estimates based on annual surveys (FWP file data) indicated a current population of 500 - 1000 at Spotted Bear, and 50-100 on and around Firefighter Mountain. These two big game winter ranges adjacent to Hungry Horse Reservoir were selected for initial enhancement activities.

STUDY AREA(S)

FIREFIGHTER

The Firefighter Mountain winter range (Firefighter) is on the northeast end of the reservoir (Fig. 1). Firefighter was selected to be the focal area for initial enhancement efforts, because it presented the greatest opportunity for improvement. Though dominated by fire-caused shrubfields when the dam was built, the Firefighter area is now primarily forested, as conifers have gradually encroached into the openings. These dense seral lodgepole pine stands have limited value to elk. Today, only about 200 acres of natural open areas remain on Firefighter, with openings typically less than 30 acres in size. We assumed that the low wintering population at Firefighter is a result of this habitat condition, with forage availability playing an important role in limiting the population.

As defined for this project, this winter range comprises approximately 28,160 acres. Enhancement activities were limited to an area approximately 7000 acres in size in the core of the winter range.

SPOTTED BEAR

The Dry Parks / Spotted Bear winter range (Spotted Bear) lies at the southeast end of Hungry Horse Reservoir, and encompasses a portion of the South Fork drainage above the reservoir, as well as the lower portion of the Spotted Bear River drainage (Fig. 2). As defined for this study, the winter range is bounded on the west by the reservoir and the South Fork, and on the east and south by wilderness boundaries, comprising approximately 45,000 acres.

The southern portion of the Spotted Bear winter range is primarily forested. The Dry Parks area, on the other hand, is dominated by fairly steep western exposures with very large

shrubland areas interspersed with smaller patches of timbered habitat.

PROJECT GOALS AND OBJECTIVES

The primary goal of the project is to increase habitat diversity and therefore elk carrying capacity in currently occupied winter range areas through habitat enhancement. Specific goals include creation of foraging habitat (openings of <=20 acres) in areas where natural succession has caused dense forest to replace seral shrubfields; and rejuvenation of existing, shrub-dominated openings through prescribed burning. We hope to increase habitat quality / availability for mule deer by incorporating their habitat needs into the design of habitat treatments planned primarily for elk, (e.g. providing additional spring range areas through the creation, treatment or expansion of openings).

An additional, essential project goal was to design and implement an intensive opulation monitoring program which would allow assessment of population responses to habitat treatment. Specifically, our goals were to: 1) determine bounded estimates of baseline elk populations using the two winter ranges; 2) design and implement surveys to monitor populations through estimation of population size and dynamics; 3) determine baseline patterns of distribution within winter ranges; 4) design and implement surveys to document changes in distribution over time; 5) determine baseline and post-treatment patterns in habitat use and food habits; and 6) design and implement systematic surveys to monitor changes in habitat use.

The primary goals of our habitat (vegetation) monitoring program are to describe baseline habitat condition, and design and implement a vegetation monitoring system which allows determination of habitat responses to treatment. Site-specific monitoring goals were to: 1) determine the species composition, condition, and utilization of browse forage species in treatment and control sites, and 2): determine species composition, density, cover values of dominant and subdominant plant species, and forage production in treatment areas, before and after treatment.

METHODS

POPULATION MONITORING

Baseline population and habitat data collection began during late fall, 1987. Marked elk have been used to determine current distribution and seasonal use patterns. Population monitoring has concentrated on establishing baseline information, and on

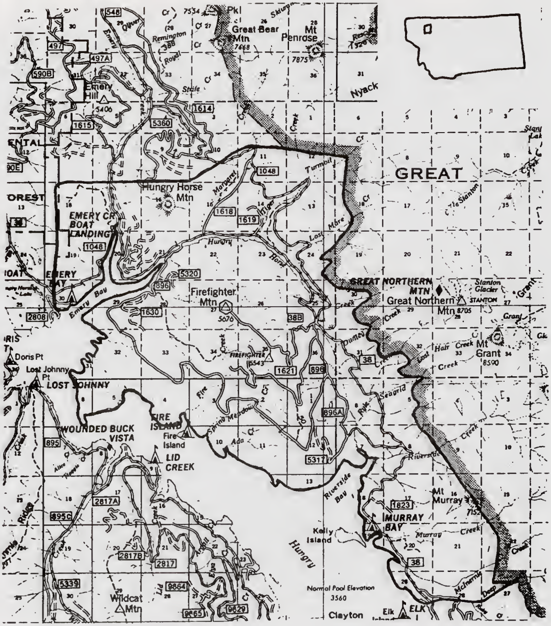

Figure 1. Map of the Firefighter Mountain winter range, adjacent to Hungry Horse Reservoir, northwest Monatna.

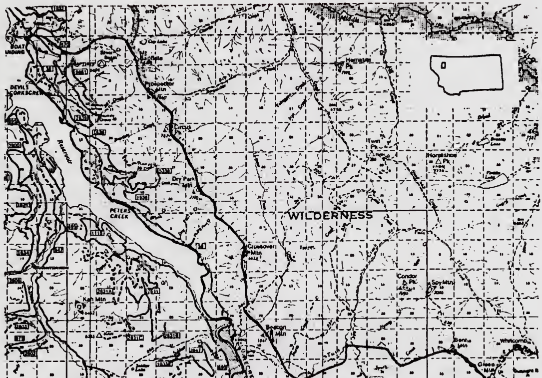

Figure 2. Map of the Spotted Bear winter range, adjacent to Hungry Horse Reservoir, northwest Montana.

testing methods for assessing response to pilot habitat treatments. We determined, and will maintain, a marked sample size (>45 elk at Firefighter) adequate for determining population estimates accurate to within ±10 percent with 95 % confidence (Rice and Harder 1977). In order to improve the efficiency of future monitoring efforts, we have collected detailed sightability data. The original estimate of 25% observability for fixed-wing surveys of this herd, developed by Biggins (1975), was tested using a double aerial sampling scheme similar to that developed in Idaho by Samuel et al. (1987). This method assesses observability (sightability) as a function of group size, canopy coverage, and other factors (Samuel et al. 1987).

Fieldwork, data collection and analysis for the report period (15 May 1991 -31 July 1992) concentrated on: 1) attaining a marked sample of >45 elk at Firefighter; 2) gathering enough aerial survey data to refine baseline population estimates; and 3) building the database needed for a sightability model.

Trapping

Elk were primarily captured using modified Clover traps (Clover 1956, Thompson et al. 1989). One corral trap was also constructed in each of the two winter ranges. Trapsites were selected based on elk use, accessibility, and previous trapping results (Casey and Malta 1990b). Trapsites were distributed so as to identify baseline distribution for various herd segments within the winter range. Clover traps were run at two new sites, and four of 18 sites used during previous years, at Firefighter during the winter of 1991/92 (Fig. 3). No trapping was conducted at Spotted Bear during the report period.

Sex of trapped animals was determined by the presence/absence of antlers and/or inspection of the genitals. Age classes (0.5, 1.5, 2.5-6.5, and >6.5 yr old) were estimated from incisor eruption and wear (Quimby and Gaab 1957). Elk were marked with standard, single-pulse radio-transmitter collars. Radio-collars were also equipped with color-marked neckband material for individual recognition. Similar neckbands were put on elk which did not receive radio-collars. All marked elk were also marked with large yellow stock-tags in each ear to increase observability. These were individually numbered as a further means to identify individual animals.

Population Surveys

Aerial (fixed-wing) surveys were the primary method used to collect population data. We attempted to conduct aerial surveys of both winter range areas at least twice monthly during Sept.-May, and at least monthly during the summer. During each survey, we recorded the location, number and general habitat type of each elk or group of elk. Visual confirmation of radio-collared animal locations,

and classification (age/sex) data were collected whenever possible, and all relocations were mapped on mylar-coated orthographic aerial photos or topographic maps of the area. Population indices were calculated almost entirely from aerial survey data, though sign survey data were also used to indicate trends.

We made an intensive effort to classify elk on summer range during August and September flights. Elk were classified as cow, calf, spike, raghorn, or branch-antlerd bull (BAB). We classified marked, reproductive-age cows observed as: "with calf", "likely with calf", "unknown", "likely no calf" and, "no calf". For example, cow 5319 was seen in the company of two other cows and 2 calves on 1 September. On 17 September she was seen alone with a calf, and on 1 October was observed suckling a calf in the company of 2 other cows and a raghorn bull. Hence we considered her "with calf". Likewise cow NBWAV was observed alone on 5 August, but on 1 September was seen walking across a large, open flat near the head of McInernie Creek accompanied only by a calf at heel.

"Likely" catagories included elk we were less sure about such as those seen in mixed groups and/or only once. For example, cow 5042 was seen in a group made up of 4 cows and 3 calves, and again in a group of 8 cows and 5 calves and was considered "likely with calf". Conversely, those put in the "likely no" catagory were either seen only once without a calf, or seen in groups with low (≤0.4) calf:cow ratios.

Distribution / Habitat Use

Long term trends in distribution and habitat use by elk and deer are being monitored within and around the treatment areas, particularly to determine if increased use over time indicates an actual population increase or merely a shift in distribution. The locations of all elk and mule deer (groups) seen within the project area were mapped to describe current seasonal distribution and habitat use patterns within each winter range. Composite maps of the number of elk group locations by UTM block were developed for Firefighter, to display seasonal patterns in distribution. A location was defined as an elk group of any size, located either visually or by radio receiver. Hence a single, unmarked elk was weighted equally with a group of 10 elk including three marked animals. This removed part of the bias caused by low sightability and interactions of marked animals. Calving areas and other important seasonal use areas were identified through plotting of digitized radio-location data, and through the seasonal elk group density maps. Distribution and juxtaposition of winter home ranges were useful for identifying important segments of the Firefighter winter range, and for delineating herd unit boundaries.

Multiple Mark-Resighting Estimates

Mark-resighting estimates (Rice and Harder 1977) were developed from aerial survey data. Our goal was to gather enough data using marked animals to generate 95% confidence intervals of ±10% around our mean population estimates. Mark-resighting estimates were developed from 7 double-sample flights and 1 helicopter survey

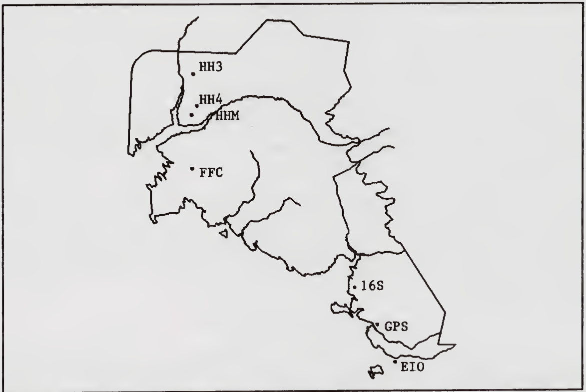

Figure 3. Elk trapsites, winter 1992/93, Firefighter Mountain winter range area.

flight at Firefighter. A recapture (resighting) was defined as a visual relocation of a marked animal. Adjustments were made for marked animals known to be outside the area intensively surveyed, and for known emigration and mortality.

Sightability Model Development

Aerial surveys conducted during winter (15 Dec. - 15 May) were designed to provide data which could be used to develop a sightability model (after Samuel, et al. 1987). Two complete passes over the winter range were conducted during each such flight. The radio receiver was not used during the first pass, and all elk seen were classified (when possible) and counted. General canopy coverage class (0-5, 5-25, 25-50, 50-75, 75-95, 95-100 percent), group size, and activity were noted for each group. Any

marked animals seen during the first pass were noted, and individually identified when possible. During the second pass, we searched for radios using a receiver, recording all data as described for the first pass. Sightability values were then defined as the percent of groups containing radio-marked animals (within the study area), which were seen during the first pass.

Data from double-sampling surveys was used to develop sightability curves (models) based on canopy coverage and group size, for each winter range segment (herd unit). These variables were found by Samuel et al. (1987) to be the most important variables determining sightability of elk in an Idaho study area. Sightability values were calculated for known-size groups containing marked elk, as described for all groups. (For example, if marked elk were present in groups of 7 elk on 10 occasions, and these groups were seen during the first pass on 5 of those occasions, sightability for that group size (7) was 0.50 or 50 percent.) Linear and/or exponential regressions were then run to examine the relationship between sightability and group size (and canopy cover class). These regressions were performed annually and with the pooled 5-yr data.

The double-sampling data also provided an opportunity to calculate mark-resighting estimates free of the bias caused by intensive efforts to see marked (radio-collared) animals. Only first pass data were used for mark-resighting estimates.

All animals seen during aerial surveys were classified by age class and sex. These classification data are used to supplement other trend data in the South Fork as part of the Region's elk management program. Population age structure was also determined through examination of trapped animals and the collection of teeth at hunter check stations.

Pellet-Group Transects

Habitat conditions and elk use patterns were assessed in part through the use of pellet-group / browse utilization transects. Loft and Kie (1989) showed that pellet-group transects accurately reflect deer habitat use during seasonal use periods. This effort served as a pilot study to determine the number of transects necessary to adequately describe habitat use. Because of the large number of transects needed to accurately estimate population size based on pellet-group data (Neff 1968), population estimation was not an objective. Cursory estimates were developed for comparison to aerial survey data.

Pellet-group strip transects were established in proposed treatment sites, adjacent control sites, and at a set of random locations stratified by elevation, aspect and canopy coverage class (Casey and Malta 1990b). Sixty potential (random) transect sites were selected in the Firefighter winter range, and subsets of 13-15 of

these random points were sampled during each year that pellet transects were run (1988, '89, '91 and '92). Stratification allowed for analysis of pellet group (elk) densities based on these variables (elevation, aspect, canopy cover class) for use in planning efforts. Pellet-group transects were run at least once (1-4 times) at each of 15 proposed treatment sites and 7 additional control sites during the baseline report period.

Transect sites were permanently marked with a metal fencepost and are hereafter referred to as "monitoring sites". Transects were 250 m long, with starting points permanently marked (Fig. 4). All pellet groups within 2 m on either side of the center line were counted and cleared. Total area sampled on each transect was 1000 sq m, or 0.1 ha (0.25 acres). The approximate age, and species were recorded for each pellet group. We defined winter as the period 15 Dec. - 15 May. Only those groups classified as "new", "moderately new" or "fresh" (if prior to 15 May) were used to calculate elk and deer-use estimates. Pellet-group age classification was subjective, and was based on color, texture, cohesiveness and site characteristics. Through such classification and clearing the transects, we hoped to reduce the error due to mis-classification of pellet-group age (Van Etten and Bennett 1965).

Food Habits

Food habits of elk were determined by microhistological examination of fecal samples collected on winter range. Processing of samples was done by AAFAB Composition Analysis Laboratory of Fort Collins CO. A sample consisted of 2-3 pellets collected from each of ≥10 pellet groups. Pellets were collected fresh, then frozen and later oven-dried for >1 hour at >250°F.

VEGETATION MONITORING

Browse-Utilization Transects

Browse-utilization transects (Cole 1959, Stickney 1966) were used to describe the species composition and condition of shrub species at random, treatment and control sites. Transect methods were described in detail in our FY90 annual report (Casey and Malta 1990b), and involve taking measurements at 50 shrubs along a 125-m transect (Fig. 4). Browse utilization data were collected at 14 stratified random sites during either 1988 or 1989, 13 treatment and 4 control sites during 1991, and at 10 treatment and 4 control sites during 1992. Relative abundance of shrub species was calculated as the percent of 50 shrubs measured at each site. Browse utilization was estimated by calculating the mean percent (number) of twigs browsed (Stickney 1966) for shrubs of a given species encountered at each site. An index of shrub vigor was developed for each species sampled by averaging the mean length of the previous year's annual growth on 5 randomly selected shoots for

up to 25 individual shrubs per transect. A comparison of pre- versus post-treatment huckleberry twig length was done with Student's t on data transformed to its natural log (Zar 1974).

Browse transect data were used to describe baseline conditions at individual monitoring sites, primarily pre-treatment conditions at proposed enhancement sites. Pooled data for certain types (e.g. natural openings, timber sale units, random sites) were used to identify patterns of browse distribution, abundance, and utilization, but it should be recognized that these sites were not true replications.

ECODATA Plots

We selected standardized methods from the USFS ECODATA handbook to collect detailed vegetation data from browse transect sites in treatment and control sites (Casey and Malta 1990b). These methods provide data compatible with other USFS projects, and the data sheets, methods, and analysis software are all in place at the USFS District level. Ocular plots with a 37-ft diameter were used to describe general vegetation characteristics at each of the sites (Fig. 4), and the short nested microplot method (ECODATA handbook) was used to describe species composition, density, and production in detail. This method is designed to assess such changes statistically, through the determination of the nested rooted frequency of selected plant species. This method is particularly well suited to monitoring changes over time as a function of management activities, for a selected group of species, and results in estimates of ground cover, biomass by life form (production, optional), species composition, nested rooted frequency, foliage canopy coverage, and density (optional) for those species selected. We used the optional method for production, since this variable will serve as an important measure of enhancement success. This involved clipping and weighing (gm) part or current annual production on each microplot to develop estimates of grass, forb and shrub production for each site sampled. At each site, we recorded data for preferred and dominant forage species, including shrubs, grasses and forbs. Plots were run at the permanently marked browse transect sites (Fig. 4). Five, 20x20 in. microplots were sampled along each of five, 66-ft transects randomly spaced along and perpendicular to the baseline (browse transect). ECODATA plots were sampled at 11 treatment sites and one control site in both 1991 and 1992.

Photo-Documentation

Photos were taken at selected treatment and control sites in order to document habitat changes over time. At least 3 photos were taken at the permanent monitoring site markers (fenceposts) in the following sequence: A) looking down the transect from the fencepost; B) looking back toward the fencepost from a point 10 m along the transect (the opposite direction from A), and C) looking

into the treatment unit from point B, in the direction(s) best representing the features of the stand (Fig. 4). The date, site and azimuth of each photo were recorded on a board in each photo. No cover board was used, so these photos were used for qualitative purposes only.

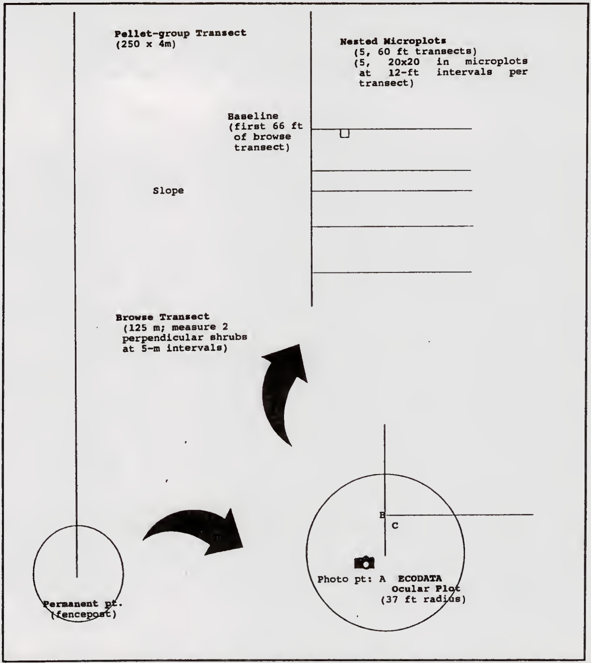

Figure 4. Configuration of monitoring site pellet-group and browse utilization transect, ECODATA plot, and photo-points, Firefighter.

RESULTS AND DISCUSSION

POPULATION DATA

Trapping

All trapping in FY93 was done at Firefighter. Twenty eight elk and 17 mule deer were caught during 192 trap nights.

Elk -- Overall trapping success averaged 6.2 trap-nights/elk and ranged from 2.1 during April to 8.3 during February (Table 1). Trapping success at individual trap sites at Firefighter is shown in Appendix A. As of 1 October we assumed 43 marked elk (28 functional radios, 3 non-functioning, 12 neckbands) in the Firefighter population (Appendix B). At Spotted Bear, we assumed 26 marked elk (6 functional radios, 1 non-functional, 19 neckbands) (Appendix C) as well as one known dead in the field. Trapping success for individual traps at Spotted Bear during 1988-1991 are shown in Appendix D.

Among 28 elk captures during the report period, radio collars were put on 7 new study animals, collars or neckbands were replaced on 5 recaptured animals, there were 11 other recaptures, and 5 animals escaped. Two escapees got away because the door on the Clover trap failed to close completely, 2 while folding the Clover trap, and 1 tore the netting of the trap. The 7 newly-marked animals were all female and included 1 calf, 2 yearlings, 1 estimated at 3½, and 3 in the 2½-6½ age class.

One of the recaptured and recollared animals caught at Firefighter was a cow that had originally been marked at Spotted Bear. What is now cow 5087 was first caught as a calf at Spotted Bear on 13 March 1990 and fitted with a neckband (yellow with black "Y's"). She was last observed on Spotted Bear ranges on 27 June 1991 and first observed at Firefighter on 10 October of that year. Therefore she emigrated from her natal home range as a 2 year old sometime during July, August or September.

Mule deer -- The 17 mule deer captured included 6 does (1 fawn, 5 adults) which were neckbanded, 7 bucks (3 fawns, 1 yearling, 2 adults, and 1 unknown age) which were released because a neckband could constrict their neck during the rut, 3 recaptures, and 1 mortality of a female fawn which was trampled by an adult doe caught in the same Clover trap. This brings to 10 the number of mule deer which have been marked at Firefighter.

From 1988 to 1990 there were 11 mule deer marked at Spotted Bear.

Population Surveys

We collected 415 radio and neckband relocations of elk at Firefighter during the report period. This brings our total to 1,894 relocations at Firefighter during the study (Fig. 5).

Table 1. Elk trapping success (trap-nights/elk) by month[a], year and trap type, Firefighter and Spotted Bear winter ranges, 1987-1992.

		Month						Entire Winter
		Dec	Jan	Feb	Mar	Apr	May	
Firefighter Clover Traps:								
1987/88		---	8.0	5.3	7.5	6.0	---	7.1
1988/89		12.0	13.0	14.0	7.5	2.5	---	7.6
1989/90		1.8	2.5	10.0	7.7	1.0	---	6.0
1990/91		---	9.0	2.4	3.3	1.3	---	3.0
1991/92		---	4.0	5.4	3.4	---	---	5.3
1992/93		---	8.7	12.8	6.6	1.5	---	7.9
	$\bar{x}$	6.9	7.5	8.3	6.0	2.1	---	6.2
Firefighter Corral Trap:								
1990/91		---	4.0	9.0	11.0	2.0	---	26.0
1991/92		---	3.0	12.0	4.0	2.0	---	12.0
1992/93		---	---	---	2.8	2.0	---	3.2
	$\bar{x}$	---	3.5	10.5	5.9	2.0	---	13.7
Spotted Bear Clover Traps:								
1987/88		16.0	1.8	4.0	4.0	---	---	2.3
1988/89		3.0	---	6.0	4.0	---	---	4.8
1989/90		---	2.4	---	12.0	---	---	4.8
1990/91		---	---	3.0	---	---	---	3.0
	$\bar{x}$	9.5	2.1	4.3	6.7	---	---	3.7
Spotted Bear Corral Trap:								
1987/88		---	---	---	---	---	---	---
1988/89		---	---	---	---	---	---	---
1989/90		---	5.0	---	0.3	---	1.0	0.5
1990/91		---	---	0.3	---	---	---	0.3
	$\bar{x}$	---	5.0	0.3	0.3	---	1.0	0.4

[a]Values for April 1988 at Firefighter, December 1988, and March 1990, at Spotted Bear clover traps; May 1990 at the Spotted Bear corral trap, and January, March and April 1991, Feb. - April 1992, and April 1993 at the Firefighter corral trap are minimum values (no elk were caught).

Figure 5. All elk relocations 1988-1993 (n=1,894), Firefighter Mountain.

Distribution -Firefighter. Relocations and winter censuses show 2 distinct herd units using Firefighter Mountain in winter and for parts or all of other seasons. The northern unit ranges from Firefighter north to Hungry Horse and Desert Mountains in winter, and in summer some of these animals move to high elevation basins such as the heads of Margaret, Tiger, and Lost Mare Creeks (Fig. 6). Few animals from the north unit have been found south of the head of Hungry Horse Creek. A portion of the northern herd unit stay on Firefighter winter range year-round.

Elk of the southern herd unit generally spend winter south of Firefighter Mountain near the mouths of Murray and McInernie Creeks. In summer most of the south unit elk move up in elevation and can be found from Murray Creek south to Canyon Creek (Fig. 7).

During winter the two herd segments remain nearly autonomous and are separated by the Dudley Creek and "Greenslope" area on the south side of Firefighter Mountain (Fig. 8).

Distribution - Spotted Bear. While we have de-emphasized work at Spotted Bear, some data were collected. The 4 winter herd units at Spotted Bear identified by Biggins (1975) are still readily apparent, centering roughly on the Dry Parks, Horse Ridge, Bent Creek, and Spotted Bear mountain areas, though some intermingling of marked animals was observed. With the exception of a "resident" herd that remains year-long in the vicinity of Spotted Bear Mountain, most of these animals move into the Great Bear and Bob Marshall wildernesses during summer. One cow (5127) summered in the North Fork of the Sun River and spent one of the 3 winters that we followed her there. Both she and a neckbanded cow which emigrated to the Firefighter population moved as 2 year olds.

Population Structure

Monitoring of population structure through classifications is important in determining productivity. Moreover, year-round classifications will help us evaluate seasons and localities (i.e. winter range, summer range) of mortality, especially among calves.

We completed 8 winter classification flights in 1992/93 at Firefighter (Appendix E). In aggregate, we observed 30.2 calves and 15.6 bulls per 100 cows. This is the lowest number of calves seen during the study and differs significantly from the 1987-1992 average of 40.9 calves:100 cows (χ^2 1 d.f.=3.865, P=.0496). It is, however, similar to the 1988/89 ratio of 32.6 calves:100 cows.

Classification data among individual flights within each year varied widely at Firefighter (Appendix E). This underscores the need for repeated sampling in the vein of Harder and Rice (1977) in order to obtain reliable data. For our comparison we used only those flights where we saw ≥25 total animals. Within individual

Figure 6. All elk relocations from the north herd unit on Firefighter Mountain, 1988-1993.

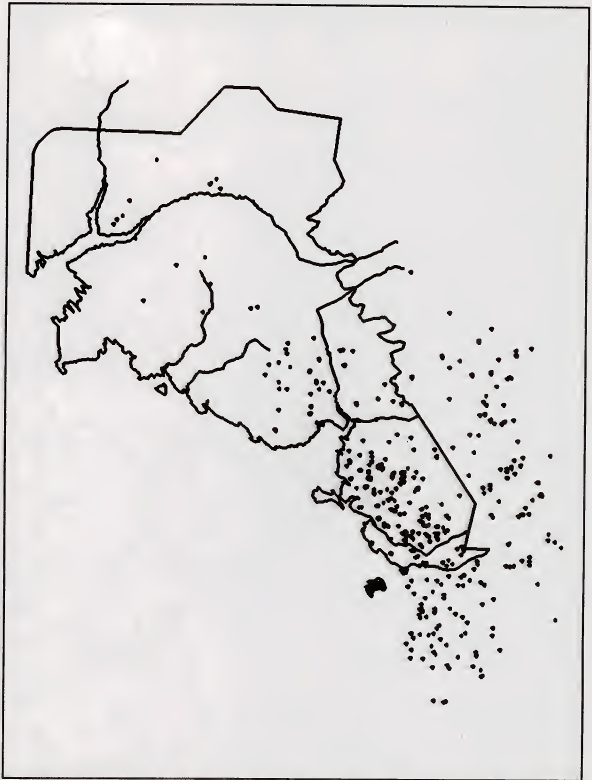

Figure 7. All elk relocations from the south herd unit on Firefighter Mountain, 1988-1993.

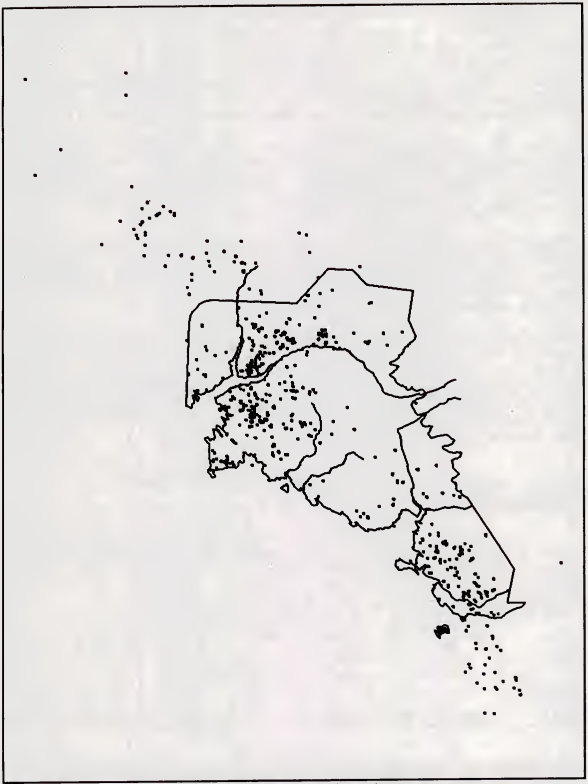

Figure 8. Winter relocations of Firefighter elk.

years, the coefficient of variation for cow:calf ratios averaged 31% (range 26-37%). For bull:cow data it averaged 62% (range 48-75%). Variability in these data from Firefighter is an artifact of small samples, and perhaps misclassification of animals. Although we often observed ≥25% of this small population (≈175 animals), absolute numbers of animals seen was frequently <75 and misclassification of a few animals could skew ratios measurably. Similar biases and difficulties were noted by Simmons (1974).

Starting in this report period we made intensive efforts to classify elk on summer/fall range. Because one goal of mitigation at Hungry Horse is to increase elk numbers through increased productivity and/or surivorship, an understanding of and baseline data on these population parameters is vital.

We found that onset of the rut facilitated classifications because elk were grouped and more visible than earlier in the summer. Moreover, any differences in habitat use, and thus sightability, between reproductive and barren cows in summer is minimized during the rut because most cows participate.

During August and September radio-relocation flights we classified 181 elk on summer range. Calf: and bull:100 cow ratios averaged 50.3 and 35.0 respectively (Table 2). Although the calf:cow ratio did not differ significantly from the long-term average of winter classifications (χ^2 1 d.f.=2.027, P=.1545), we suspect this to be in part related to small sample sizes. The suggested decline in calves bears further investigation.

Table 2. Summer/fall 1993 classifications of elk on the Firefighter study area.

Date	Total Class.	Cows	Calves	Bulls		Per 100 Cows	
				BAB	Spk	Calves	Bulls
08/05	40	23	12	4	1	52.2	21.7
08/18	24	14	8	2	0	57.1	14.3
09/01	68	35	20	12	1	57.1	37.1
09/17	16	7	4	3	1	57.1	57.1
10/01	33	18	5	9	1	27.8	55.6
Total	181	97	49	30	4	50.5	35.0

We also used marked reproductive-age cows as a sub-sample of all elk and one for which we could trace each cow's reproductive history through repeated sightings. This is of particular importance when addressing the survivorship of calves. Between 1

August and 1 October we observed 26 marked reproductive-age cows from the Firefighter population 1-5 times each for a total of 56 observations (Table 3). For 14 animals we determined weather or not they were ever attended by a calf, and another 9 we placed into "likely" categories. Reproductive status of 3 marked cows observed was not determined.

Table 3. Reproductive status of marked reproductive-age cow elk from the Firefighter Mountain population during August and September, 1993 as determined on aerial flights.

With Calf	Likely With Calf	UnKnown	Likely No Calf	No Calf
4004[a]	4112	5172	4049	4151
5058	5042	5205	4303	5191
5098	5117	5293	5181	5242
5319	5160		5314	5252
5331			5376	5282
5360				5390
NBWAVE				
NBARROW				

[a] Elk identification number/code.

Calf:cow ratios among marked animals were similar to those observed among all elk (Table 3). We expected that calf:cow ratios among reproductive-age cows would be higher than among all elk because the latter includes largely barren yearlings and 2 year olds (Kittams 1953, Flook 1970).

The calf:cow ratio among the marked sample classified as "with" or "without calf" was 57.1:100. Higher, but not significantly different than that observed among all elk (χ^2 1 d.f.=.2151, P=.6428). Adding the "likely" categories to the marked sample gave a calf:cow ratio of 52.2:100, still closer to that observed among all elk (χ^2 1 d.f.=.0204, P=.8863).

The causes and timing of calf mortality are important to quantify if we wish to monitor productivity over time in the Firefighter population. Repeated sightings of marked elk suggest that some cows are losing calves during summer and fall. For example, cow 5360 was seen on 5 August in a large clearcut in a group made up of 5 cows, 5 calves and 2 bulls. On 18 August she was observed by herself with a calf at heel. Based on these 2 sightings we determined she had a calf. On 1 and 17 September she was seen in groups (6 cows, 4 calves, 2 bulls and 4 cows, 2 calves, 2 bulls

respectively) where she may or may not have had a calf. However, on 1 October she was seen at the head of Riverside Creek accompanied only by a raghorn bull.

Although later than the 1 October end date for this report, some data from the 1993 hunting season support our "with calf"-"no calf" classifications of marked cows. We looked at 3 marked cows killed during season. Two of these also offered some information about summer calf mortality.

Cow NBWAV, which we had determined had a calf at heel (Table 3), was killed on 24 October and was noted to have milk in her udder, a certain indication she was attended by a calf (Kittams 1953, Flook 1970).

We thought cow 5360 had reared a calf but lost it sometime in late August or early September (see above). When killed on 27 October the hunter found no milk in her udder. However, she was accompanied by a calf which the hunter thought behaved as though it were hers. We believe that had it been her calf she would have been lactating. Flook (1970) found that 100% of cows in Banff National Park which still had their calf lactated until mid-December, some much later. Also, she not having any milk is communserate with her losing her calf in August or September. She would most likely would have "dried up" by the time she was killed (D. Kinyon, DMV, pers. comm.). Having lost hers, another calf may have formed a bond with her, or she with it. This would be especially likely if the latter had lost its dam, a not unlikely event during hunting season.

Observatons on cow 5242 also provides some evidence. She was observed on 5 August in a group with 2 other cows, a spike, and one calf. We saw her 3 times after that but never in the company of any calves so we classified her as "without calf". Sometime between 23 October and about 6 November she was apparenly wounded and not recovered. We found her on 11 November dead for less than a week of a gunshot wound. Her udder was examined by one of us (J.V.) and 2 other FWP biologists (D. Casey and B. Campbell). Each agreed there was no milk in the udder, but, based on the condition of the teats, she had suckled a calf sometime during the summer. If so, we suspect she lost it before mid August.

The suspected difference between summer and winter calf:cow ratios begs explaination. One may be the higher sightability of elk during the rut when compared to winter. Casey and Malta (1992) found cow/calf groups on Firefighter sought heavier cover in winter than other elk groups. But during the rut, these same cow/calf groups may be more visible as pointed out earlier. It is also true that calves are being preyed upon, although to what degree is unknown. Gunther (1990) found grizzly predation on neonatal calves in Yellowstone National Park, but that it declined as calves grew older and was not seen after calves were 35-45 days old. Murie

(1940) and Vore (1990) each documented June and July mortalities to unknown causes among mature elk in Yellowstone National Park. Schlyer (1983) found grizzlies in Yellowstone preying on elk throughout spring, summer and fall. Williams (1992) found that mountain lions in the Sun River area of Montana preyed on elk year-round.

Mortality

We predict that enhacement efforts at Hungry horse will have beneficial effects on both the productivity and survivorship of elk. An understanding of the latter necessarily involves some knowledge of mortality factors. Also, it is important that we address the issue of increasing vulnerability to harvest through habitat enhancement and associated roads. Therefore we have undertaken to determine causes of death among marked animals.

Firefighter -- There were 9 known mortalities (20%) among the 45 marked elk at Firefighter during the report period (Table 4). Six of the 9 (67%) were known or suspected to be related to hunting. Three mortalities were determined to have been natural, 2 where the cause was undetermined and another where it was found a tree had fallen on the animal. Calculated mortality rates are conservative because mortality among neckbanded animals (no radio collar) is difficult to quantify.

There were 2 radio-marked bulls in the Firefighter population going into the report period (Appendix F) One was killed the opening day of the 1993 archery season. Although it falls outside the 1 October end of the report period, the other was killed 26 October. These data and those from previously marked bulls suggest a high mortality rate among bulls in the Firefighter population.

Mortality rate during the report period among marked cows at Firefighter was at least 19% (8 of 41). Five of the 8 (63%) were hunting-related, thus hunting mortality alone accounted for at least 12% of Firefighter cows.

Spotted Bear -- The radio-marked sample at Spotted Bear is too small at this time to make a reliable estimate of mortality. However, the pattern of mortality sources, natural versus hunting, appear different than those seen at Firefighter. Among 4 marked elk known to have died, 3 died of natural causes. The causes remain unknown. However, fat content in the femur marrow of 2 of them showed they did not die of malnutrition.

In addition to investigation mortalities occuring during the report period, we retrieved the collars of 2 bulls which died sometime prior. Bull 4102 died in Glacier National Park of unknown causes. Although it is uncertain when he died, from the condition of the single radius bone found ≈100 m from the collar on 2 October 1993, we felt he died ≥1 year previous. The collar of bull 4041 was

retrieved on 27 August 1993 from Ouzel Creek. Based on aerial relocations, he died sometime between 19 September and 28 November 1990. The presence of a fire ring and discarded soft drink can at the steep, alder-choked collar location lead us to speculate it was a hunting mortality.

Table 4. Mortalities among marked elk of the Firefighter and Spotted Bear populations from July 1992 to October 1993.

ID	Sex	Mortality Date	Cause/Comments
		Firefighter	
4102	M	07/09/91-08/20/93	Unknown in GNP
4122	F	11/23/92-01/27/93	Unknown, Wounding?
4311	M	09/07/93	Hunting, Archery
5221	F	02/25/92-03/13/92	Unknown, Winter Kill?
5340	F	10/27/92	Hunting
5350	F	08/15/92-09/03/92	Natural, Tree fell on
Blue XX	F	10/29/92	Hunting
Blk XX	F	Approx. 11/01/92	Wounding Loss
Blue Star	F	<05/03/93	Unknown, Winter Kill?
		Spotted Bear	
5022	F	10/25/92	Hunting
5127	F	03/26/92-08/20/93	Unknown, Natural?
5142	F	11/14/91-02/21/92	Unknown, Natural?
NB/DBLST	F	<07/25/93	Unknown, Natural?

Mortality rates among South Fork cows are similar to those found in other Montana herds. Hamlin and Ross (1992) noted a mortality rate of 14% among marked cows in Montana's Gravely Mountains from 1984 to 1992. Ninety percent of this (12.6%) was hunting related. In the Elkhorn Mountains of Montana from 1982-1991, DeSimone and Vore (1992) observed a 15% rate among cows with 13% (89% of the total) attributed to hunting.

Mark-Resighting Estimates

Firefighter -- Seven mark-resighting census flights were flown at Firefighter during the winter of 1992/93 (Table 5). The population estimate and 95% c.i. for the 1992/93 winter was 106±20, lower than

that for any of the previous 3 winters (Table 6). We attributed the low estimate to emigration of elk north to lower elevations along the flanks of Desert Mountain (Casey 1993). During 1992/93 an average of 12% (range 4-19%) of radio-marked elk were outside the regular survey area compared to 5% (range 2-11%) during the winter of 1991/92.

Table 5. Aerial survey data, mark-recapture estimates of elk populations in the Firefighter Mountain winter range area during winter 1992/93.

Survey Date[a]	Total Marked(M)[b]	Total Seen (C)	Marked Animals Seen (R)	Observability (R/M)	Population Estimate(N)[c]
01/27	32	9	3	.10	82
03/04	34	12	3	.09	113
03/04	34	13	6	.18	69
03/06	34	10	2	.06	127
03/30	37	44	13	.31	121
04/06	43	48	18	.42	112
04/07	43	47	17	.40	116

[a] Double-sample fixed wing and helicopter surveys only; estimates developed from first pass only.

[b] Includes all marked animals known or assumed to be in population (survey area) at time of survey.

[c] $N=[(M+1)(C+1)/(R+1)] - 1$ (Rice and Harder 1977, after Chapman 1952).

Table 6. Winter population estimates for Firefighter Mountain since 1989.

Year	Population Estimate	95% c.i.
1989/90	186	145-227
1990/91	136	100-172
1991/92	193	143-243
1992/93	106	86-126

During 1992/93, the 95% c.i. was ±19% of the population estimate. This compares with ±22, 26, and 26% during 1989/90, 1990/91 and 1991/92 respectively. A goal of monitoring efforts on Firefighter is to be able to obtain population estimates with a 95% c.i. of ±10%. It remains to be seen if increased sample size (number of animals or flights) can improve the precision of these estimates

below ±20% (Casey and Malta 1992). However, we believe greater precision can be obtained with an increased sample size.

Spotted Bear -- No mark-resighting estimates were developed for the Spotted Bear population during the report period.

One difficulty encountered in estimating elk populations at both Firefighter and Spotted Bear is knowing with certainty the number of marked animals available in the population. All estimates have been developed adjusting for radio-marked animals outside the survey area. However, unless seen and known otherwise, all neckbanded animals were assumed to be "in". This has perhaps led to an overestimation of the number of marked animals assumed to be in the survey area (M). This bias in turn would result in an overall population (N) over-estimation. Population estimates will be recalculated and future ones made by by applying the percentage of radios known to be in to the neckbanded population.

Elk Sightability

During the last 5 years, 293 elk groups with ≥1 radio-collared elk in the group were available for analysis of elk sightability at Firefighter. Overall sightability of all groups was 22%. Two variables are known to strongly affect elk sightability at Firefighter: size of the group and canopy cover (Casey and Malta 1992).

One hundred sixty elk groups were used in analyzing the relationship between group size and sightability (Table 7). There was a significant relationship between group size and sightability (r^2=.7349, P=.0068). However, groups ≥7 fell further from the regression line than did groups of ≤6 elk. Among groups of <7 elk there was a very strong (r^2=.992) and significant (P=.0000) correlation between group size and sightability (Fig. 9). It is known cow/calf groups and/or groups ≥7 sought heavy cover and were therefore less visible (Casey and Malta 1992).

Analysis of the relationship between canopy cover and sightability was done using 293 elk groups (Table 8). No radioed elk were ever found in an area with canopy cover of 95-100%, so this category was dropped from analysis. Among remaining categories canopy cover strongly influenced elk sightability. There was a highly significant relationship between the $\log_{10}$-transformed percent of elk groups observed and canopy cover (r^2=.994, P=.0000)(Fig. 10).

Future analysis will investigate the interrelationship between canopy cover and group size in the development of a sightability model for Firefighter Mountain.

Table 7. Sightability of Firefighter elk by group size.

Group Size	Seen	Not Seen	Total	Percent Observed
1	3	32	35	8.6
2	4	13	17	23.5
3	3	7	10	33.3
4	6	7	13	46.1
5	8	7	15	53.3
6	9	5	14	64.3
7-15	23	28	51	45.1
16+	5	0	5	100

Table 8. Sightability of Firefighter elk groups by canopy cover class.

Canopy Cover	Seen	Not Seen	Total	Percent Observed
0-5%	20	4	24	83.3
6-25%	13	18	31	41.9
26-50%	27	90	117	23.1
51-75%	4	98	102	2.9
76-95%	0	19	19	0
95-100%	0	0	0	0

Pellet-Group Transects

Thirty-four pellet transects were run during the report period. Since 1988, 41 pellet transects have been run from 1 to 5 times (Table 9) at treatment, random and control points located on Firefighter. The number of new and recent pellet groups observed per transect during 1993 ranged from 0 to 25 (Table 9). Transects in natural openings (G,J,L, and M) consistently had the highest number of groups while those in forested habitats had the least. Baseline data in treatment areas will afford the opportunity to evaluate changes in elk use following treatment.

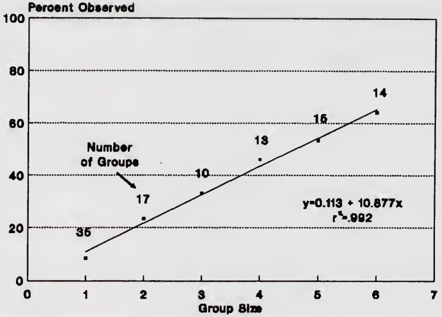

Figure 9. Elk sightability by group size on Firefighter Mountain.

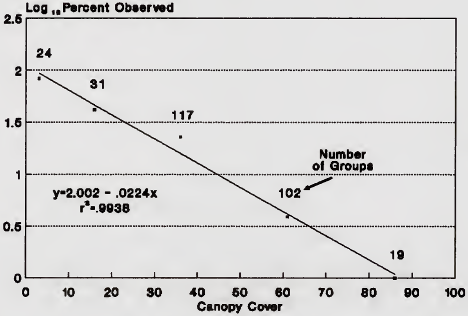

Figure 10. Elk sightability by cover class on Firefighter Mountain.

Table 9. Number of fresh and recent elk pellet groups observed on 1000 m^2 transects, 1988-1993, Firefighter Mountain.

Transect Type and Number		Year 88	89	91	92	93	Mean
Treatment:	14	3	0	1	0	0	0.8
	33			2			2
	36			0			0
	54			0	0	0	0
	57			0	0		0
	58			0	0		0
	A			0	1	0	.33
	B			0	0	0	0
	C			1	1	1	1
	D		1	2	0	1	1
	E			2	4	1	2.33
	F		0				0
	G			24			24
	J	36	9	11	24	25	21
	L					14	14
	M		8	8	5	7	7
Random:	1	1					1
	3	1	0	0	1	0	0.4
	4	8	4	14	0	0	5.2
	5	4	1	2	1	3	2.2
	6	1	1	3	0	0	1.0
	7	2	1	0	0	0	0.8
	9	0		4	0	3	1.4
	10	1		7	4	1	3.25
	11	1		0	1	1	0.75
	12	6	2	1	1	4	2.8
	13	1	3	4	5	3	3.2
	15	1	0				0.5

Continued

Table 9. Concluded.

Transect Type and Number		Year					
		88	89	91	92	93	Mean
Random:	16	0	7	11	9	10	7.4
	17	5		19	7	3	8.5
	19		7		4	2	4.3
	20		6			4	5.0
	21		0	0	0	1	0.25
	23		3	1	0	2	1.5
Control:	2	0	0	0	0	0	0
	27C			0	5	1	2
	36A			1	1	1	1
	AC	0	0	0	1	4	1
	BC	0	0	0	0	0	0
	CC		2	0	0	2	1
	EC		0	3	0	0	0.75

Food Habits

Six monthly pellet group samples (Table 10) and 3 samples representing entire winters (Table 11) were collected and analyzed for Firefighter. A February 1991 sample was analyzed for Spotted Bear (Table 12).

Pacific yew and Oregon grape were the most common food items identifiable in elk feces from Firefighter during all seasons and years (Tables 10,11). Among monthly samples collected during the winters of 1991 and 1992, these two species averaged 61.5% of identifiable items (range 58.0-74.2)(Table 10). Among composite samples for the entire winters of 1988, 1991, and 1992, they represented a mean of 68.1% of elk diets (range 63.5-75.5)(Table 11).

Other taxa representing over 15% of elk diets in any collection included Douglas fir, willow, and larch (Table 10). Because larch is a deciduous conifer, we thought elk were picking up larch needles incidental to feeding on other plants, in particular Oregon grape. However, there was no correlation between the amount of Oregon grape and larch in diets when using the 6 monthly samples for 1991 and 1992 together with the composite sample for 1988

(r^2=0.136). Elk either selected for larch needles or picked them up incidental to feeding on some other forage. Larch was an important food item on the Spotted Bear winter range (Table 12). Pacific yew is not generally considered a preferred winter browse plant for elk. Although Nelson and Leege's (1982) literature review lists yew receiving moderate to heavy winter use and being valuable to highly valuable, 4 of 5 references they cite do not mention yew (Rouse 1957, Wing 1962, Trout and Leege 1971, and Moran 1973), and Hash (1973, Table 7) shows winter use as being very slight. In a summer study of elk food habits in Oregon's Blue Mountains, Korfhage et al. (1980) found yew to be 13 and 10% of diets in 1972 and 1973 respectively. Daneke (1980) noted yew receiving light winter use in the Middle Fork of the Flathead during 1 winter of a 2 year study. It was not used during any other season.

Oregon grape is more commonly known to be a part of elk diets. Nelson and Leege (1982) state that it is of limited value and used lightly. Daneke (1980) noted that Oregon grape was an important winter food of elk in the Middle Fork of the Flathead during 1978-79. It made up an average of 15% (range 9.1-20.8%) of elk diets as determined by fecal analysis. If further research on Firefighter continues to show the importance of yew and Oregon grape to wintering elk, it will be an important contribution to current knowledge of elk diets in similar habitats. More importantly, it may cause us to re-assess our approach to habitat enhancement.

Douglas fir and larch together made up 71.9% of a February 1991 fecal sample from the Spotted Bear winter range (Table 11). More intensive sampling from this winter range will be required in order to describe elk diets confidently. Daneke (1980) found that Douglas fir made up an average of 26.2% of elk winter diets in the Middle Fork of the Flathead, and that combined conifers were 63.0% of yearly diets. He documented no use of larch.

Oregon grape and Pacific yew were rarely encountered on browse transects. Although Oregon grape was present on most browse transects, few plants of this species grow tall enough (≥0.2 m) to have been considered a browse plant available in winter. Moreover, taxa such as Serviceberry and rose, clearly important as forage items based on browse transect data, were either represented minimally or not identified in fecal samples. Daneke (1980) also noted that plants known to be important browse from back-tracking browse transects were not evident in fecal pellets. We will continue to use browse transects and fecal pellet samples to document browse utilization/food habits as enhancement proceeds. Sampling techniques will be modified as necesary to insure proper sample sizes for preferred browse species.

An explanation for the discrepancy between fecal analysis and browse transects may lie in the fact that often 40-60% of items on a prepared fecal-sample microscope slide are unidentifiable (T.

Foppe, AAFAB lab, Pers. Comm. Oct. 6, 1993). The methods used by AAFAB in microhistological analysis depends upon the identification of leaf parts in determining species. Since many browse species are deciduous and elk eat only twigs in winter, it is suspected that much of the unidentifiable material were leaders from those species known to be important browse. Further pellet collections combined with different analysis techniques will begin during the winter of 1993/94.

Table 10. Mean percent relative density of discerned fragments from elk fecal samples collected monthly on Firefighter Moutain during winters 1991 and 1992.

Taxa	Jan 91	Feb 91	Mar 91	Jan 92	Feb 92	Mar 92
Grasses						
<u>Bromus</u>		.50	8.36		.96	2.44
<u>Carex</u>		4.61	3.34	1.83	7.11	12.55
<u>Danthonia</u>		.44				
<u>Juncus</u>				3.26	2.10	6.41
<u>Stipa</u>					.57	.65
Forbs						
<u>Lupinus</u>						.57
Fern						.51
Moss			.45			
Trees and Shrubs						
<u>Larix</u>	9.27	2.74	17.56	17.48	6.65	4.05
<u>Berberis</u>		9.27	53.76	45.76	60.22	45.40
<u>Juniperus</u>	1.73					
<u>Pachistima</u>		6.04				
<u>Pinus</u>				5.71	.49	1.62
<u>Pseudotsuga</u>	15.06	6.81	7.75	6.01	4.74	13.25
<u>Salix</u>	16.10	4.64	3.27	7.67	8.25	7.69
<u>Taxus</u>	57.84	64.95	5.51	12.28	8.91	4.86

Table 11. Mean percent relative density of discerned plant fragments from composite elk fecal samples from Firefighter Mountain for the entire winters of 1988, 1991 and 1992.

Genus	1988	1991	1992
Grasses			
Bromus	1.24	7.33	6.20
Carex	6.53	1.34	9.78
Juncus	5.11		2.68
Stipa		.55	1.00
Forbs			
Equisetum			
Moss			
Trees and Shrubs			
Berberis	28.05	16.75	60.28
Ceanothus	8.54	2.07	
Equisetum	.65		
Juniperus		.77	
Larix		6.06	6.45
Pinus		1.03	1.60
Pseudotsuga	.59	9.18	5.58
Rubus	.59		
Salix	.64	7.73	.54
Seed		.46	.46
Taxus	47.46	46.73	5.03

VEGETATION DATA

Browse Utilization

One new browse transect (L) was established in a natural opening on the southwest slopes of Firefighter Mountain. A total of 36 transects which have now been sampled for 1 to 4 years (Table 13). Sixteen transects were read during the 1993 field season.

Twenty-nine browse species have been encountered on browse transects. Among these, 6 were selected for study emphasis based on high use indices (rose, maple, willow and serviceberry), known

elk forage preference (redstem ceanothus), and suitability for assessing changes in the shrub community (huckleberry)(Casey and Malta 1990).

Table 12. Mean percent relative density of discerned plant fragments from 1 sampling of elk fecal pellets on the Spotted Bear winter range in February of 1991.

Taxa	Percent Relative Density
Grasses	
Bromus	9.35
Carex	4.12
Trees and Shrubs	
Berberis	1.95
Juniperus	1.69
Larix	36.31
Pseudotsuga	35.56
Rubus	1.26
Salix	2.15
Taxus	7.61

We now have have 2 to 4 years of pre-treatment data for transects in forested habitats scheduled for treatment. Huckleberry typically dominated forested transects although rose was common on transects on the south side of Firefighter in lodgepole-dominated stands (transects E, F, 36, and 57)(Table 13). Huckleberry also dominated on a thinned-larch transect (33) and among 14 random points in predominately forested habitats (Table 13). Serviceberry was the dominant shrub species in natural openings (Table 13).

Based on use indices, rose and willow are the preferred browse in forested habitats (Table 14). Redstem ceanothus was only found in low density on transects in natural openings. However, where found it was heavily utilized.

Table 15 presents data on pre-treatment annual growth among the 6 selected species. These data will be used in assessing changes caused by treatment.

Table 13. Pre-treatment relative abundance data from browse transects, 1988-1993, Firefighter Mountain Winter Range, for selected species.

		SHRUB SPECIES											
Transect type and number	No. Years	Maple $\bar{x}$	Maple Range	Serviceberry $\bar{x}$	Serviceberry Range	Redstem $\bar{x}$	Redstem Range	Rose $\bar{x}$	Rose Range	Willow $\bar{x}$	Willow Range	Huckleberry $\bar{x}$	Huckleberry Range
Forested[a]													
FF-A	3	0	-	.08	(.08-.1)	0	-	.02	(0-.06)	.05	(.02-.08)	.63	(.52-.74)
FF-B(82)	3	0	-	0	-	0	-	.03	(0-.04)	0	-	.74	(.70-.80)
FF-C(82)	3	0	-	.05	(0-.12)	0	-	.01	(0-.02)	.05	(0-.10)	.70	(.66-.76)
FF-D	3	0	-	.06	(.04-.08)	0	-	0	-	.01	(0-.02)	.72	-
FF-E(85)	3	0	-	.02	(0-.04)	0	-	.36	(.32-.38)	0	-	.48	(.44-.54)
FF-F	2	0	-	0	-	0	-	.36	(.32-.40)	0	-	.23	(.16-.30)
FF-36	3	0	-	.33	(.32-.38)	0	-	.15	(.10-.22)	.01	(0-.02)	.18	(18-20)
FF-54	3	0	-	.01	(0-.02)	0	-	0	-	.04	(.02-.08)	.73	(.68-.76)
FF-57	2	.01	(0-.02)	.08	(.04-.12)	0	-	.53	(.46-.60)	0	-	.01	(0-.02)
FF14(69)	4	0	-	0	-	0	-	.01	(0-.02)	0	-	.72	(.66-.84)
Natural Opening[b]													
FF-G	1	0		0.48	-	.08	-	.08	-	0	-	0	-
FF-J	2	.01	(0-.02)	0.34	(.30-.38)	.02	(0-.04)	.08	(.06-.10)	.02	-	.02	(0-.04)
FF-M	2	0	-	0.50	(.48-.52)	.04	(.02-.06)	.07	(.06-.08)	.05	(.04-.06)	.03	(.02-.04)
Thinned Larch[c]													
FF-33	2	0	-	0.03	(.02-.04)	0	-	.04	-	.04	(.02-.06)	.51	(.46-.56)
Random Points[d] (N=14)	1	.05	(0-.16)	0.11	(0-.32)	0	-	.10	(0-.34)	.03	(0-.14)	.38	(.10-.84)

[a]Proposed timber sale units [b]Prescribed burn units [c]Browse slashing unit [d]Mean values for random (forested) points.

Table 14. Pre-treatment browse use indices[a] from browse transects, 1988-1993, Firefighter Mountain Winter Range, for selected species.

		SHRUB SPECIES											
Transect type and number	No. Years	Maple $\bar{x}$	Range	Serviceberry $\bar{x}$	Range	Redstem $\bar{x}$	Range	Rosa $\bar{x}$	Range	Willow $\bar{x}$	Range	Huckleberry $\bar{x}$	Range
Forested[b]													
FF-A	3	-	-	.05	(.00-.50)	-	-	00	-	.33	(0-.60)	.01	(.00-.25)
FF-B(82)	3	-	-	-	-	-	-	.21	(0-.56)	-	-	.01	(.00-.40)
FF-C	3	-	-	.00	-	-	-	.28	-	.14	(0-.17)	.00	(.00-.29)
FF-D	3	-	-	.12	(.03-.25)	-	-	-	-	.11	(.00-.33)	.01	(.00-.01)
FF-E(85)	3	.43	-	.09	(00-.20)	-	-	.48	(0-100)	-	-	.05	(.00-.50)
FF-F	2	-	-	-	-	-	-	.25	(0-100)	-	-	.05	(.00-.33)
FF-36	3	-	-	.09	(0-.57)	-	-	.17	(0-.88)	.20	-		(.00-.25)
FF-54	3	-	-	00	-	-	-	-	-	.06	(.00-.25)	.01	(.00-.40)
FF-57	2	.00	-	.31	(.22-.39)	-	-	.25	(.18-.31)	-	-	.00	-
Natural Opening[c]													
FF-G	1	-	-	.03	-	.56	-	00	-	-	-	-	-
FF-J	2	.00	-	.13	(.10-.16)	.70	-	.04	(.02-.22)	.00	-	.41	-
F-M	2	-	-	.12	(.10-.13)	.16	(.08-.23)	.02	(.00-.03)	.39	(.22-.45)	.00	-
Thinned Larch[d]													
FF-33	2	-	-	.13	(.04-.21)	-	-	.03	(.00-.60)	.38	(.00-.75)	.02	(.00-.04)
Random Points[e] (N = 14)	1	.07	(.00-.25)	.13	(00-.53)	-	-	.11	(.00-.37)	.19	(.00-.65)	.07	(.00-.31)

[a]Percent of twigs browsed (# browsed/total) [b]Proposed timber sale units [c]Prescribed burn units [d]Browse slashing unit
[e]Mean values for random (forested) points.

Table 15. Pre-treatment twig length (mm)[a] data from browse transects, 1988-1993, Firefighter Mountain Winter Range, for selected species.

Transect type and number	No. Years	Maple $\bar{x}$	Maple Range	Serviceberry $\bar{x}$	Serviceberry Range	Redstem $\bar{x}$	Redstem Range	Rosa $\bar{x}$	Rosa Range	Willow $\bar{x}$	Willow Range	Huckleberry $\bar{x}$	Huckleberry Range
						SHRUB SPECIES							
Forested[b]													
FF-A	3	-	-	22.1	(2-186)	-	-	-	-	144	(34-379)	27.4	(2-123)
FF-B(82)	3	-	-	-	-	-	-	75.4	(8-170)	-	-	26.3	(2-210)
FF-C	3	-	-	3.5	(1 - 17)	-	-	16.4	(4-33)	67.6	(19-183)	24.4	(3-150)
FF-D	3	-	-	16	(11- 22)	-	-	-	-	211	-	31	(24-41)
FF-E(85)	3	17.2	4-33	6.9	(2-29)	-	-	54.3	(2-468)	-	-	36.6	(1-215)
FF-F	2	-	-	-	-	-	-	34.9	(3-135	-	-	19.7	(2- 68)
FF-36	3	-	-	39.5	(2-249)	-	-	131.6	(157-287)	-	-	36.7	(5-119)
FF-54	3	-	-	4	-	-	-	-	-	140	-	18.56	(2-180)
FF-57	2	-	-	100	(33-166)	-	-	84	(62-106)	-	-	-	-
Natural Opening[c]													
FF-G	1	-	-	8	-	109	-	121	-	-	-	-	-
FF-J	2	6	3-10	19	(2- 91)	-	-	42	(9-255)	194	(90-330)	19	(12-24)
F-M	2	-	-	21	(2-211)	93	(11-280)	94	(6-650)	57	(22- 99)	19	(2-42)
Thinned Larch[d]													
FF-33	2	-	-	-	-	-	-	16	(15- 18)	145	(31-259)	39	(37-41)
Random Points[e] (N=14)	1	42	(16-92)	43	(18-106)	-	-	108	(26-493)	70	(25-309)	39	(26-62)

[a]Annual growth, previous year [b]Proposed timber sale units [c]Prescribed burn units [d]Browse slashing unit
[e]Mean values for random (forested) points.

Two of the forested treatment areas were cut in 1992 and burned in the spring of 1993. Timber harvest began in many remaining treatment units during summer of 1993, and many are scheduled to be burned in the spring of 1994. The FY94 field season will therefore be the first opportunity to collect post treatment data from a variety of treatment sites at Firefighter.

ECODATA Plot Data

Five ECODATA plots were read during the report period. Computer compilation and analysis of ECODATA plot data was not completed for this draft report. A list of all plant species encountered on ECODATA plots was compiled (Appendix F)

VEGETATION RESPONSE -- PRELIMINARY INDICATIONS

Enhancement work in forested habitats began the summer of 1992; treatment will not be completed in these units until they are burned in spring 1994. We therefore have few data for describing vegetation response. However, comparative data from natural shrubfields burned in spring 1991 and 1992, browse slashing units from 1991, and a random control point which fell in a previously-logged unit were available for comparison.

Natural openings G, J, and M were prescription-burned in the spring of 1991 with poor results (Casey and Malta 1992). They were slashed later in the summer of 1991 and reburned in the spring of 1992 with somewhat better yet still marginal results. Most shrub response was apparently due more to slashing than burning.

Transects in openings J and M provide 3 years pre- and 1 year post-treatment data. Treatment did not affect relative abundance of plants (Table 16). The effect of treatment on browse use is not readily apparent and we will need data from future years for a full evaluation (Table 16). Serviceberry was the only species encountered with enough frequency on these transects to provide for valid statistical comparisons. This reiterates the need to revise sampling techniques in future years to provide a more quantitative analysis of the effects of habitat enhancement. Browse use of serviceberry increased on transect J following treatment (χ^2 1 df=17.37, P=.0000) but remained the same on transect M (χ^2 1 df=1.626, P=.2022).

Twig length appeared to increase for all species following treatment (Table 16). Again, except for serviceberry, sample sizes were too small for analysis. Among serviceberry plants, length of previous year's annual growth increased by 358 mm following treatment on transect J (*t* 70 df=14.70, P=.0000), and 123 mm on transect M (*t* 76 df=7.085, P=.0000)(Table 16).

Table 16. Mean values of selected measurements of selected plants on browse transects in natural openings on Firefighter Mountain pre- (1988-1990) vs. post-slash and burn treatment, (1991-1993).

Transect	Pre/Post Treatment	Maple	Service-berry	Redstem Ceanothus	Rose	Willow	Huckle-berry
			Relative Abundance[a]				
J	Pre	.01	.34	.02	.08	.02	.02
	Post	0	.36	.02	.04	.02	.02
M	Pre	0	.50	.04	.07	.05	.03
	Post	0	.46	0	.12	.08	.02
			Browse Use Indices[b]				
J	Pre	0	.13	.70	.04	0	.41
	Post	--	.31	.80	.22	.33	0
M	Pre	--	.12	.16	.02	.39	0
	Post	--	.07	--	0	.05	0
			Twig Length (mm)[c]				
J	Pre	6	19	--	42	194	19
	Post	--	377	230	--	357	28
M	Pre	--	21	93	94	57	19
	Post	--	214	--	255	571	51

[a] No. plants of species/total No. browse plants observed
[b] No. browsed leaders/total No. leaders
[c] Previous year's annual growth of unbrowsed leaders

STATUS OF ENHANCEMENT ACTIVITIES

Enhancement activites at Firefighter include timber harvest, slashing and burning of unmerchantable tees, prescribed burning in natural shrubfields, and slashing browse in previously tinnned forest stands (Casey and Malta 1990c). There have been a few changes in treatment prescriptions since the 1990 planning. Unit 49 was originally slated for harvest but was not sold so will be slashed. Unit 57, originally slated for slashing and burning was purchased as a post and stake unit. Figure 11 shows distribution of treatment units on Firefighter Mountain.

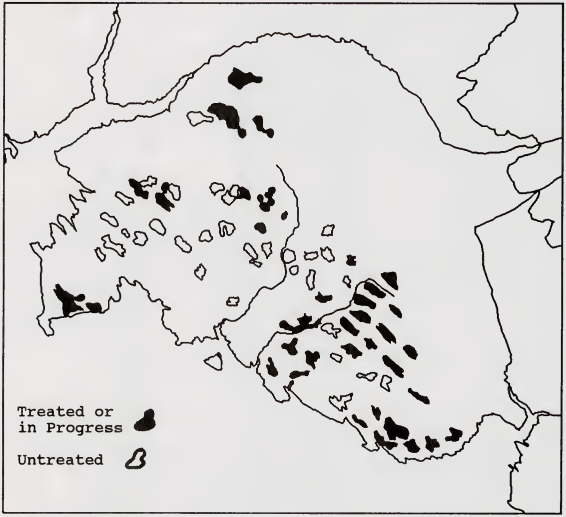

Figure 11. Location and status of treatment areas on Firefighter Mountain.

TIMBER HARVEST

Forty two forested units (24 as sawlog and 18 as stake and post) on Firefighter totaling about 573 acres were slated for harvest. To date 25 have been harvested including 14 sawlog units and 11 stake and post (Appendix G). Of these 25, treatment has been completed with post-harvest burning on 2 units. Burning on the remaining units is schuduled for spring 1994.

PRESCRIBED BURNING

Eight of 9 natural shrubfields slated for prescribed burning were completed by the end of the report period. The remaing one, unit 11, was combined with unit 62, a forested stand surrounding unit 11. And they will be treated together to make more efficient use of time and money as well as making the burn easier to acomplish.

BROWSE SLASHING

Six of seven units scheduled for slashing have been completed. Four were slashed in 1991, 2 in 1993 and the remaing one is scheduled for treatment in 1994-96.

SLASH AND BURN

Eight of nine units scheduled for slashing and buring were slashed during the summer and fall of 1993. Burning on these units is slated for completion in the spring of 1994. The remaining unit (unit 01), is in the sale's grizzly bear subdivision where activities are scheduled for 1994-96 and treatment is slated during that time.

FY 94 PLANNED ACTIVITIES

MONITORING

We will continue with all aspects of monitoring as outlined previously. However, changes and additions to project activities are discussed below.

TRAPPING

We will make an attempt this coming winter to trap elk by net gunning from a helicopter. If successful, this will prove time and cost efficient, and will allow more time for the pursuit of other aspects of the project such as data analysis, food habit and nutrition field work, and the development of GIS maps. We will contract with experienced personnel such as Helicopter Wildlife Management of Salt Lake City, UT. There is little doubt they will be able to operate effectively and cost efficiently on Spotted Bear winter ranges where we hope to mark 8 elk. We hope to mark 12 elk

at Firefighter. Net gunning at Firefighter will pose more of a challenge due to the heavy canopy cover and protruding snags. In the event it proves too dangerous or costly to net gun at Firefighter we will again use the corral and Clover traps.

Aerial net gunning will allow us to target certain sex and/or ages for marking. We radio collar elk for 4 reasons: 1) to determine movements, distribution, and habitat use, 2) to determine productivity and survivorship of calves of marked females as discussed in "Population Structure", 3) to determine rates and causes of mortality among marked animals, and 4) development of our sightability model. In order to maximize information gained from the marked sample we will concentrate on marking calves (7-10 months old). These will serve not only in addressing all study goals using marked elk, but, because we are assuming about one half of calves marked will be males, will help in investigating bull-specific mortality. At this time we do not wish to mark adult bulls becase it is known that they use different habitats than cow/calf groups (Peek and Lovass 1968, Geist 1982) and would therefore offer less for our development of the sightability model. However, marked as calves, they are likely to associate with cow/calf groups for about 2 years before dispersing.

FOOD HABITS AND NUTRITION

We will continue collecting pellets at both Firefighter and Spotted Bear in order to further define and/or assess changes in elk food habits with enhancement activities. Samples will be sent to the Wildlife Habitat Laboratory in Pullman, WA which employs a technique which can identify some bark fragments. In this manner we hope to minimize the problems with unidentifiable fragments as discussed earlier.

Because it is hoped that enhancement activities will increase both the quantity and quality of forage it is necessary to quantify the changes in elk nutrition. Beginning this year we will be collecting information on the winter nutritional status of populations. We will do this through analysis of nitrogen and diaminiopemelic acid (DAPA) in elk feces (Nelson et al. 1986), and by determination of urea nitrogen:creatinine (U:C) ratios in elk urine (DelGiudice and Seal 1988, DelGiudice et al. 1991, DelGiudice et al. 1991b).

DAPA is an amino acid produced by microfauna in the rumen and, unlike many other microbial byproducts, is not taken up by the elk. Byproducts such as DAPA increase with increasing microbial activity in the rumen. This activity increases with increasingly favorable nutritional condition of the host (in this case elk) and is less as condition decline. Therefore, relative levels of DAPA can be used as an index of nutritional regime. U:C ratios are used as indicators of winter nutrition in elk by determining weather or not the animal is catabolizing body protiens for energy.

CALF SURVIVAL

Because an objective of habitat enhancement is to increase elk productivity through increased survivability of calves, it is necessary that we develop an understanding of the factors affecting it. Toward this end we will make an effort next June to capture at least 6 neonatal calves for marking. They will be fitted with ear tag transmitters and monitored.

GEOGRAPHIC INFORMATION SYSTEM (GIS)

In the event that aerial net gunning is successful it will afford us the opportunity to develop our use of GIS. This will entail the development of a base map and necessary layers for analysis such as roads, habitat types, and treatment areas. Many maps have already been digitized and are available, however, we need the time for familiarization with the program and the integration of our data into it.

DATA ANALYSIS

There remains much work to be done with existing collected data. Development of the sightability model, an analysis of relocations at Spotted Bear, analysis of ECODATA plots and other tasks have not been done largely because of the time needed to trap elk in winter. Here again, if aerial net gunning is successful we will be able to devote time towards these ends.

REFERENCES CITED

Ackerman, B.B., F.A. Leban, M.D. Samuel, and E.O. Garton. 1990. User's manual for Program Home Range. Second Edition. Tech. Rept. 15, Forestry, Wildl. and Range Exp. Sta., Univ. Idaho, Moscow. 80pp.

Aldous, C.M. 1944. A deer browse survey method. J. Mammal. 25:130-136

Biggins, D.E. 1975. Seasonal habitat relationships and movements of the Spotted Bear elk herd. Montana Dept. Fish and Game Job Final Rept. Proj. No. W-120-R-6 and 7. Study No. BG-3.2, Job No. 1. 90pp.

Bissell, G.N., and C.A. Yde. 1985. Wildlife and wildlife habitat mitigation plan for Hungry Horse hydroelectric project. Prep. by Montana Dept. Fish, Wildlife and Parks for Bonneville Power Admin., Portland, OR. 90pp.

Casey, D.C. 1993. Quarterly Progress Report, Northwest Montana wildlfe habitat enhancement, Hungry Horse elk/mule deer project. Jan-15 Apr 1993. Mont. Dept. Fish, Wildl. and Parks. Kalispell. 5pp.

______, and Malta, P.R. 1990. Northwest Montana wildlife habitat enhancement: Hungry Horse elk mitigation project. Interim (Annual) Rept. Montana Dept. Fish, Wildlife and Parks, Kalispell. 85pp.

______, and ______. 1990b. Northwest Montana wildlife habitat enhancement: Hungry Horse elk mitigation project. Monitoring and evaluation plan. Montana Dept. Fish, Wildlife and Parks, Kalispell. 56pp.

______, and ______. 1990c. Hungry Horse dam wildlife habitat enhancement project: long-term habitat management plan elk and mule deer winter range enhancement Firefighter Mountain and Spotted Bear winter ranges. Montana Dept. Fish, Wildlife and Parks, Kalispell. 89pp.

______, and ______. 1991. Northwest Montana wildlife habitat enhancement: Hungry Horse elk mitigation project. Annual Rept., FY91. Montana Dept. Fish, Wildlife and Parks, Kalispell. 41pp.

______, and ______. 1992. Northwest Montana wildlife habitat enhancement: Hungry Horse elk mitigation project. Interim (Annual) Rept. Montana Dept. Fish, Wildlife and Parks, Kalispell. 66pp.

______, C.A. Yde, and A. Olsen. 1984. Wildlife impact assessment and summary of previous mitigation related to hydroelectric projects in Montana. Vol.III - Hungry Horse Project. Prep. by Montana Dept. Fish, Wildlife and Parks for Bonneville Power Admin., Portland, OR. 66p.

______, H. Rivera, S. Riley, J. Harper, T. Grotzinger, and H. Nyberg. 1988. Northwest Montana wildlife habitat enhancement: Elk/Mule deer winter range, Hungry Horse Reservoir. Prep. by Montana Dept. Fish, Wildlife and Parks and USDA Forest Service for Bonneville Power Admin., Portland, OR. 30pp.

Clover, M.R. 1956. Single-gate deer trap. Calif. Fish and Game. 42:199-201.

Cole, G.F. 1959. Key browse survey method. Proc. Annu. Conf. West. Assoc. State Game and Fish Comm. 39:181-185.

Daneke, D.E. 1980. Forage selection and population structure of the Middle Fork elk herd. Mont. Dept. of Fish, Wildl. and Parks Job Final Report. Project No. W-120-R-11 (5893). Study No. BG-3.3. Job No. 2. 74pp.

DelGuidice, G.D, and U.S. Seal. 1988. Classifying winter undernutrition in deer via serum and urinary urea nitrogen. Wildl. Soc. Bull. 16:27-32.

______, _____, and L.D. Mech. 1991. Indicators of severe undernutrition in urine of free-rangeing elk during winter. Wildl. Soc. Bull. 19:106-110.

______, F.J. Singer, and U.S. Seal. 1991b. Physiological assessment of winter nutritional deprivation in elk of Yellowstone National Park. J. Wildl. Manage. 55(4):653-664.

DeSimone, R. and J. Vore. 1992. Elkhorn elk monitoring project: 1991 annual report. Mont. Dept. Fish, Wildl. and Parks. Helena. 110pp.

Flook, D.R. 1970. A study of sex differential in the survival of wapiti. Can. Wildl. Serv. Rep. Ser. No 11. Ottawa:Queens Printer. 71pp.

Geist, V. 1982. Adaptive behaviorial strategies. Pages 219-277 <u>in</u> Thomas, J.W. and D.E. Toweill <u>eds.</u> Elk of North America: Ecology and Management. Stackpole Books, Harrisburg, PA. 698pp.

Gunther, K.A. 1990. Grizzly bear predation on elk calves and other fauna of Yellowstone National Park. Int. Conf. Bear Res. and Manage. 8:329-334.

Hamlin, K.L. and M.S. Ross. 1992. Elk population dynamics and breeding biology: progress report 1992. Mont. Dept. Fish, Wildl. and Parks. Bozeman. 27pp.

Hash, H.S. 1973. Movements and food habits of the Lochsa elk. M.S. Thesis. Univ. Idaho, Moscow. 85pp.

Hayne, D.W. 1949. Calculation of size of home range. J. Mammal. 30(1):1-18.

Kittams, W.H. 1953. Reproduction of Yellowstone elk. J. Wildl. Manage. 17(2):177-184.

Korfhage, R.C., J.R. Nelson, and J.M. Skovlin. 1980. Summer diets of Rocky Mountain elk in northeastern Oregon. J. Wildl. Manage. 44(3):746-750.

Loft, E.R., and J.G. Kie. 1989. Comparison of pellet-group and radio-triangulation methods for assessing deer habitat use. J. Wildl. Manage. 52(3):524-527.

Lyon, L.J. 1979. Habitat effectiveness for elk as influenced by roads and cover. J. Forestry. 77(10):658-660.

Montana Department of Fish, Wildlife and Parks. 1992. Statewide elk management for Montana. MDFWP, Helena. 170pp.

Moran, R.J. 1973. The Rocky Mountain elk in Michigan. Wildl. Div., Res. and Dev. Rep. No. 267. Lansing, Michigan Dep. Nat. Resour. 93pp.

Murie, A. 1940. Ecology of the coyote in Yellowstone. Fauna of the National Parks No. 4. Washington, D.C.: U.S. Govt. Printing Office. 206pp.

Mussehl, T., J. Gaffney, and D.G. Conklin. 1986. Design for tomorrow, 1985-1990: A strategic plan for Montana's fish, wildlife and park resources. Montana Dept. Fish, Wilflife and Parks, Helena. 88pp.

Neff, D.J. 1968. The pellet-group technique for big game trend, census, and distribution: a review. J. Wildl. Manage. 32:597-614.

Nelson, J.R. and T.A. Leege. 1982. Nutritional requirements and food habits. Pages 323-367 in Thomas, J.W. and D.E. Toweill eds. Elk of North America: Ecology and Management. Stackpole Books, Harrisburg, PA. 698pp.

______, B.B. Davitt, and T. Hodgman. 1986. FY1986 progress report: DAPA cooperative research and development program. Department of Forestry and Range Manage., Washington Stae Univ., Pullman. 39pp.

Noste, N.V., and C.L. Bushey. 1987. Fire response of shrubs of dry forest habitat types in Montana and Idaho. USDA Forest Service Gen. Tech. Rept. INT-239. 22pp.

Peek, J.M., and A.L. Lovass. 1968. Differential distribution of elk by sex and age on the Gallatin Winter Range, Montana. J. Wildl. Manage. 32(3):553-557.

Quimby, D.C., and J.E. Gaab. 1957. Mandibular dentition as an age indicator in Rocky Mountain elk. J. Wildl. Manage. 21:435-451.

Rice, W.R., and J.D. Harder. 1977. Application of multiple aerial sampling to a mark-recapture census of white-tailed deer. J. Wildl. Manage. 41(2):197-206.

Rouse, R.A. 1957. Elk food habits, range use, and movements. Gravelly Mountains, Montana. M.S. Thesis. Monatna State Univ., Bozeman. 29pp.

Samuel, M.D., D.J. Pierce, and E.O. Garton. 1985. Identifying areas of concentrated use within the home range. J. Animal Ecol. 54(3):711-719.

______, E.O. Garton, M.W. Schlegel, and R.C. Carson. 1987. Visibility bias during aerial surveys of elk in northcentral Idaho. J. Wildl. Manage. 51(3):622-630.

Schlyer, B.O. 1983. Activity patterns of grizzly bears in the Yellowstone ecosystem and their reproductive behavior, predation and use of carrion. M.S. Thesis. Mont. State Univ., Bozeman. 130pp.

Simmons, C.A. 1974. Seasonal movements and migrations of the Spotted Bear elk herd. M.S. Thesis. Univ. Montana, Missoula. 99pp.

Stickney, P.F. 1966. Browse utilization based on percentage of twig numbers browsed. J. Wildl. Manage. 30(1):204-206.

Taber, R.D., IK. Raedeke, and D.A. McCaughran. 1982. Population characteristics. Pages 279-298 in Thomas, J.W. and D.E. Toweill eds. Elk of North America: Ecology and Management. Stackpole Books, Harrisburg, PA. 698pp.

Thompson, M.J., R.E. Henderson, T.O. Lemke, and B.A. Sterling. 1989. Evaluation of a collapsible clover trap for elk. J. Wildl. Mange. 17(3):287-289.

Trout, L.C., and T.A. Leege. 1971. Are the northern Idaho elk herds doomed? Idaho Wildl. Rev. 24(3):3-9.

USDA Forest Service. 1985. Forest Plan: Flathead National Forest. USDA Forest Service. Kalispell, MT.

______. 1989. Firefighter Mountain winter range project. Environmental Assessment, Decision Notice/FONSI. USDA Forest Service. Kalispell, MT.

Van Etten, R.C., and C.L. Bennett. 1965. Some sources of error in using pellet-group counts for censusing deer. J. Wildl. Manage. 29(4):723-729.

Vore, J. 1990. Movements and distribution of some northern Yellowstone elk. M.S. thesis. Montana State Univ., Bozeman. 80pp.

Williams, J.S. 1992. Population characteristics and habitat use of mountain lions in the Sun River Drainage, Montana. M.S. thesis. Montana State Univ., Bozeman. 109pp.

Wing, L.D. 1962. Big game and livestock browse utilization and feeding habits on a sandy range in southestern Idaho. M.S. Thesis. Univ. Idaho, Moscow. 89pp.

Zar, J.H. 1074. Biostatistical Analysis. Prentis-Hall, Inc. Englewood Cliffs, N.J. 620pp.

Appendix A. Elk trapping statistics at Firefighter Mountain, 1988-1993.

Trapsite	Trap Nites	Elk Caught	Trap Nites/Elk
HH Mtn II	20	7	2.9
Road 1623	20	6	3.3
Elk Isle Ovrlk	56	16	3.5
Road 896	21	5	4.2
HH Mtn	134	31	4.3
HH Mtn III	67	15	4.5
Murry GPS	50	11	4.6
Hungry Tiger	20	4	5.0
Deep Cr	18	3	6.0
HH Mtn IV	38	6	6.3
Firefgtr NW	36	5	7.2
FF Corral	69	9	7.7
Road 1623 So	31	4	7.8
Emery Bay Ovlk	18	2	9.0
Spur Road	32	3	10.7
Murray Campgrd	14	1	14.0
Tent Cr	17	0	---
HH Cut	17	1	17.0
Dudley Cr	17	0	---
Murray	18	1	18.0
Riverside	19	0	---

Appendix B. Marked elk of the Firefighter Mountain population as of 1 October 1993. Radio collars are black, neckbands are blue.

I.D.[a]	Sex/Age[b]	Ear Tag	Date Marked	Trap Site	Status as of 1 October 1993
4004	F/3	92-109	02/03/93	HH3	Functional
4049	F/3	90-67	01/16/91	HHM	Functional
4082	F/2	92-107	01/20/93	HHM	Non-functional
4092	F/3	88-22	03/05/93	HH4	Functional
4112	F/3	91-105	03/04/92	HHM	Functional
4129	F/3	92-108	01/28/93	HH4	Non-functional
4151	F/3	92-106	01/12/93	HHM	Functional
4158	F/4	91-103	02/12/92	EIO	Functional
4194	F/4	89-35	01/11/90	EBO	Functional
4271	F/3	99-101	01/15/92	FFC	Functional
4303	F/3	89-37	01/11/90	896	Functional
5042	F/3	88-29	02/24/93	HHM	Functional
5058	F/3	91-99	01/15/92	HHT	Functional
5087	F/3	89-56	03/19/93	FFC	Functional
5095	F/3	90-96	04/02/91	GPS	Functional
5117	F/2	92-111	03/19/93	FFC	Functional
5170	F/3	90-70	02/07/91	R16	Functional
5181	F/3	90-90	02/28/92	16S	Functional
5190	F/4	61-102	02/04/92	EIO	Functional
5205	F/3	90-71	02/08/91	GPS	Functional
5221	F/1	92-110	03/19/93	FFC	Non-functional
5232	M/2	90-72	02/08/91	EIO	Functional
5242	F/3	90-87	03/31/93	HH4	Functional
5252	F/3	88-19	01/26/89	SRD	Functional
5282	F/3	90-74	02/08/91	HH3	Functional
5293	F/2	99-100	01/15/92	FFC	Functional
5320	F/3	90-76	02/13/91	R16	Functional
5332	F/3	90-78	02/14/91	GPS	Functional

Continued.

Appendix B. Concluded.

I.D.[a]	Sex/ Age[b]	Ear Tag	Date Marked	Trap Site	Status as of 1 October 1993
5360	F/3	90-75	02/12/91	HH3	Functional
5377	F/4	92-112	04/02/93	HH4	Functional
5390	F/3	NONE	03/26/93	FFC	Functional
WT DBL DIA*	F/3	88-31	04/06/89	HHM	Assumed alive
BLK STRP	F/3	89-38	01/11/90	HHM	Assumed alive
O O O O	F/3	90-77	02/13/91	EIO	Assumed alive
WAVE	F/3	89-47	02/15/90	EIO	Assumed alive
BLUE	F/3	89-64	03/21/90	HHS	Assumed alive
> > > >	F/3	89-65	03/21/90	EIO	Assumed alive
HRSESHOE	F/4	90-92	03/22/91	GPS	Assumed alive
+ + + +	F/4	89-66	03/28/90	MCG	Assumed alive
--->	F/1	NONE	04/02/91	EIO	Assumed alive
■ ■ ■ ■	M/2	90-97	04/03/91	GPS	Assumed alive
POLKA DOTS	F/1	90-98	04/03/91	EIO	Assumed alive
▲ ▲ ▲ ▲	F/3	89-48	03/07/90	HHM	Assumed alive

[a] Radio frequency or necband symbol.
[b] Estimated age at marking. 1=calf, 2=yearling, $3=2\frac{1}{2}-6\frac{1}{2}$, $4=\geq 7\frac{1}{2}$
* This neckband is on black material.

Appendix C. Marked elk of the Spotted Bear population as of 1 October 1993. All are yellow with black symbols.

I.D.[a]	Sex/ Age[b]	Ear Tag	Date Marked	Trap Site	Status as of 1 October 1993
5004	F/3	87-03	01/21/88	HR	Functional
5010	F/3	90-79	02/23/91	DR	Functional
5033	F/3	87-07	01/24/88	SP	Functional
5044	F/3	90-81	02/24/91	PB	Functional
5073	M/3	NONE	03/11/89	FL	Functional
5103	F/3	87-08	01/24/88	DR	Functional
5127	F/3	87-14	02/24/88	HR	Animal dead in field
5160	F/3	87-15	02/25/88	SP	Non-functional, observed 09/09/93
WAVE	F/4	88-27	03/10/89	BR	Assumed alive
CHKRBRD	F/4	89-55	03/12/90	PB	Assumed alive
HRSHOE	F/2	89-54	03/12/90	PB	Assumed alive
¦ - ¦ -	F/3	90-80	02/24/91	PB	Assumed alive
CIR TRI	F/3	90-83	02/24/91	PB	Assumed alive
8 8 8 8	F/4	89-42	01/22/90	BR	Assumed alive
3 3 3 3	F/4	90-86	02/24/91	PB	Assumed alive
LAZY H	F/3	89-62	03/13/90	PB	Assumed alive
--->	F/3	89-41	01/21/90	PB	Observed 09/09/93
X O X O	F/4	A1128	03/12/90	PB	Assumed alive
/ - / -	M/1	89-61	03/13/90	PB	Assumed alive
X X X X	F/3	89-52	03/12/90	PB	Assumed alive
HRGLASS	F/3	89-53	03/12/90	PB	Assumed alive
¦ ¦ ¦ ¦	F/3	89-49	03/12/90	PB	Assumed alive
POLKA DOTS	F/3	89-51	03/12/90	PB	Assumed alive
T T T T	F/2	89-57	03/13/90	PB	Assumed alive
DBL STRP	F/3	90-84	02/24/91	PBC	Assumed alive
% % % %	F/2	89-59	03/13/90	PB	Assumed alive
E E E E	F/3	89-60	03/13/90	PB	Assumed alive

[a] Radio frequency or necband symbol.
[b] Estimated age at marking. 1=calf, 2=yearling, 3=2½-6½, 4=≥7½

Appendix D. Elk trapping statistics at Spotted Bear, 1988-1991.

Trapsite	Trap Nites	Elk Caught	Trap Nites/Elk
PB Corral	16	36	0.4
Dry Parks	15	6	2.5
Pole Barn	23	9	2.6
Hrse Rg III	3	0	---
Brush Cr	18	6	3.0
Crossover	14	4	3.5
Horse Ridge	12	2	6.0
Upper Twin	7	0	---
Flat Cr	7	1	7.0
Horse Rdge N	12	1	12.0

Appendix E. Summary of winter (Dec.-May) elk classifications on Firefighter Mountain, 1988-1993.

					Bulls			Per 100 Cows[c]	
Date	Type[a]	Total	Cows	Calves	BAB	Spk	Uncl♂[b]	Calves	Bulls
1992/93									
03/04	HEL	10	7	3					
03/04	FW	17	12	4	1				
03/30	FW	56	37	14	1	2	2	37.8	13.5
04/06	FW	39	29	5	1	1	3	17.2	17.2
04/06	HEL	44	29	12		2	1	41.4	10.3
04/07	HEL	43	32	7	3	1		21.9	12.5
04/27	HEL	63	39	12		5	7	30.8	30.8
05/06	FW	37	27	7		1	2	25.9	11.1
TOTAL		309	212	64	6	12	15	30.2	15.6
1991/92									
01/17	FW	57	41	11	1	4		26.8	12.2
02/11	FW	48	31	12	1	4		38.7	16.1
02/25	FW	51	37	10	3	1		27.0	10.8
03/13	FW	75	49	20	5	1		40.8	12.2
03/27	FW	65	46	13	5	1		28.3	13.0
04/07	FW	16	7	4	4	1			
04/14	HEL	67	36	19	5	3	4	52.7	33.3
TOTAL		379	247	89	24	15	4	36.0	17.4

continued

					Bulls			Per 100 Cows[c]	
Date	Type[a]	Total	Cows	Calves	BAB	Spk	Uncl♂[b]	Calves	Bulls
1990/91									
01/03	FW	22	17	4	0	1			
01/18	FW	22	15	6	0	1			
01/22	FW	47	29	16	2	0		55.2	6.9
02/06	FW	25	20	3	0	2		15.0	10.0
03/21	FW	51	31	9	6	5		29.0	35.5
03/30	FW	101	54	30	7	10		55.5	31.5
04/19	HEL	67	38	21	2	5	1	55.3	21.0
04/19	HEL	45	25	10	2	6	2	40.0	40.0
05/04	HEL	38	27	11				40.7	0
TOTAL		418	256	110	19	30	3	43.0	20.3
1989/90									
12/13	FW	84	51	27	0	6		52.9	11.8
01/12	FW	27	14	8	1	4		57.1	35.7
02/14	FW	39	28	10	0	1		35.7	3.6
03/06	FW	73	41	27	1	4		65.8	12.2
03/21	FW	40	24	12	0	4		50.0	16.7
04/18	FW	69	39	14	4	2	10	35.9	41.0
05/01	FW	33	22	7		1	3	31.9	12.1
TOTAL		365	219	105	6	22	13	45.7	18.7

continued

					Bulls			Per 100 Cows[c]	
Date	Type[a]	Total	Cows	Calves	BAB	Spk	Uncl♂[b]	Calves	Bulls
1988/89									
11/30[d]	FW	47	28	14	5			40.0	30.0
04/18	FW	34	20	8	1	4	1	50.0	17.9
TOTAL		81	48	22	6	4	1	45.9	22.9
1987/88									
03/11	FW	16	13	1		2			
03/18	FW	23	14	3	1	5			
04/01	FW	28	23	5				21.7	0
04/09	FW	30	21	7	1	1		33.3	9.5
04/16	FW	90	58	26	3	3		44.8	
TOTAL		187	129	42	5	11		32.6	12.4

[a] FW=fixed wing, HEL=helicopter
[b] Bulls with dropped antlers
[c] Ratios given only when total n≥25
[d] One day before December but is included here

Appendix F. List of plants encountered on ECODATA plots, Firefighter Mountain winter range area.

SPECIES		CODE	COMMON NAME
TREES:			
Abies	lasiocarpa	ABILAS	Subalpine Fir
Larix	occidentalis	LAROCC	Western Larch
Pinus	contorta	PINCON	Lodgepole Pine
Pinus	monticola	PINMON	Western White Pine
Pseudotsuga	menziesii	PSEMEN	Douglas-fir
SHRUBS:			
Acer	glabrum	ACEGLA	Rocky Mountain maple
Alnus	sinuata	ALNSIN	Sitka Alder
Alnus	tenuifolia	ALNTEN	Thinleaf Alder
Alnus	spp.	ALNUSX	Alder
Amelanchier	alnifolia	AMEALN	Western Serviceberry
Arctostaphylos	uva-ursi	ARCUVA	Kinnikinnick
Berberis	repens	BERREP	Creeping Oregongrape
Betula	tenuifolia	BETTEN	Paper Birch
Ceanothus	sanguinus	CEASAN	Redstem Ceanothus
Ceanothus	velutinus	CEAVEL	Evergreen Ceanothus
Cornus	stolonifera	CORSTO	Red-osier dogwood
Holodiscus	discolor	HOLDIS	Creambush Oceanspray
Juniperus	communus	JUNCOM	Common Juniper
Linnaea	borealis	LINBOR	Western Twinflower
Lonicera	utahensis	LONUTA	Utah Honeysuckle
Menziesia	ferruginea	MENFER	Fool's Huckleberry
Pachistima	myrsinites	PACMYR	Myrtle Boxwood
Potentilla	argentea	POTARG	Silver Sinquefoil
Prunus	emarginata	PRUEMA	Bitter Cherry
Prunus	spp.	PRUNX	Cherry
Prunus	virginia	PRUVIR	Common Chokecherry
Ribes	spp.	RIBESX	Currant
Rosa	spp.	ROSAXX	Rose
Rubus	parviflorus	RUBPAR	Thimbleberry
Salix	spp.	SALIXX	Willow
Sambucus	spp.	SAMBUX	Elderberry
Shepherdia	canadensis	SHECAN	Buffaloberry
Sorbus	scopulina	SORSCO	Mountain Ash
Spiraea	betulifolia	SPIBET	Shiny-leaf Spirea
Symphoricarpus	albus	SYMALB	Common Snowberry
Taxus	breviflia	TAXBRE	Pacific Yew
Vacinnium	caespitosum	VACCAE	Dwarf Huckleberry
Vaccinium	spp.	VACCIN	Huckleberry
Vaccinium	globulare	VACGLO	Globe Huckleberry
Vaccinium	scoparium	VACSCO	Grouse Whortleberry

Appendix F continued.

GRASSES:

Agropyron	spp.	AGROPY	Wheatgrass
Calamagrostis	rubescens	CALRUB	Pinegrass
Carex	spp.	CAREXX	Sedge
Festuca	idahoensis	FESIDA	Idaho Fescue
		GRASSX	Grass
Phelum	pratense	PHEPRA	Timothy

FROBS:

Achillea	lanulosa	ACHLAN	Yarrow
Adenocaulon	bicolor	ADEBIC	Trail-plant
Agoseris	ap.	AGOSER	False Dandelion
Allium	sp.	ALLIUM	Onion
Anaphalis	margaritacea	ANAMAR	Pearly Everlasting
Antennaria	microphylla	ANTMIC	Rosy Pussytoes
Antennaria	neglecta	ANTNEG	Pussytoes
Antennaria	racemosa	ANTRAC	Raceme Pussytoes
Apocynum	sp.	APOCYN	Dogbane
Arabis	spp.	ARABIS	
Aralia	nudicaulis	ARANUD	Wild Sarsaparilla
Arnica	latifolia	ARNLAT	Broadleaf Arnica
Aster	sp.	ASTERX	Aster
Calochortus	apiculatis	CALAPI	Baker's Mariposa Lily
Campanula	sp.	CAMPAN	Harebell
Chimaphila	umbellata	CHIUMB	Common Prince's Pine
Clematis	sp.	CLEMAT	Clematis
Clintonia	uniflora	CLIUNI	Queen's Cup
Cornus	canadensis	CORCAN	Bunchberry
Crucifereae	sp.	CRUCIF	Mustard
Disporum	hookeri	DISHOO	Hooker Fairy-bell
Disore	oreganum	DISORE	Fairy-bell
Epilobium	sp.	EPILOB	Willowherb
Erigeron	acris	ERIACR	Bitter Fleabane
Erigeron	divergens	ERIDIV	Diffuse Fleabane
Filago	arvensis	FILARV	Fluffweed
Fragaria	sp.	FRAGAR	Strawberry
Gallium	boreale	GALBOR	Northern Bedstraw
Gallium	triflorum	GALTRI	Sweet-scented Bedstraw
Goodyera	oblongifolia	GOOOBL	Western Rattlesnake-Plantain
Habenaria	elegans	HABELE	Elegant Rain-orchid
Heuchera	cylindrica	HEUCYL	Roundleaf Arum-root
Hieracium	albiflorum	HIEALB	White Hawkweed
Hieracium	albertinum	HIEALE	Western Hawkweed
Hypericum	perforatum	HYPPER	St. John's-wort
Listera	chordata	LISCOR	Heart-leaf Twayblade
Lupine	sp.	LUPINU	Lupine

Appendix F continued.

Melampyrum	linerea	MELLIN	Narrow-leaved Cow-wheat
Osmorhiza	chilensis	OSMCHI	Mountain Sweet-root
Pedicularis	racemosa	PEDRAC	Sickletop Lousewort
Penstemon	sp.	PENSTE	Penstemon
Potentilla	argentea	POTARG	Silver Sinquefoil
Prunella	vulgaris	PRUVUL	Self-heal
Pterospora	andromecea	PTEAND	Woodland Pinedrops
Pyrola	sp.	PYROLA	Wintergreen
Sedum	stenopetallum	SEDSTE	Wormleaf Stonecrop
Senecio	triangularis	SENTRI	Arrowleaf Groundsel
Smilacina	stellata	SMISTE	Starry Solomon-plume
Spiranthus	romanzoffiana	SPIROM	Hooded Ladies-tresses
Thalictrum	occidentalis	THAOCC	Western Meadowrue
Tiarella	uniflora	TIAUNI	Coolwort Foamflower
Trillium	ovatum	TRIOVA	White Wake-robin
Veronica	catenata	VERCAT	Speedweed
Veratrum	viride	VERVIR	Green False Hellebore
Viola	adunca	VIOADU	
Viola	sp.	VIOLAX	Violet
Viola	orbiculata	VIOORB	Round-leafed Violet
Xerophyllum	tenax	XERTEN	Beargrass

FERNS:

Athyrium	filix-femina	ATHFIL	Ladyfern
Gymnocarpium	dryopteris	GYMDRY	Oakfern
Pedicularis	bracteosa	PEDBRA	Bracted Lousewort
Pteridium	aquilinum	PTEAQU	Brackenfern

Appendix G. Status of treatment units on Firefighter Mountian as of 1 October 1993.

Unit	Treatment	Status
A	Harvest	Cut summer 1992
D	Harvest	Cut summer 1992
F	Slash/Burn	Slashed summer 1993
G	Pres. Burn	Slashed Aug. 1991, burned Mar. 1992
H	Pres. Burn	Slashed Aug. 1991, burned Mar. 1992
I	Pres. Burn	Slashed Aug. 1991, burned Mar. 1992
J	Pres. Burn	Slashed Aug. 1991, burned Mar. 1992
K	Pres. Burn	Burned Mar. 1992
L	Pres. Burn	Slashed Aug. 1991, burned Mar. 1992
M	Pres. Burn	Slashed Aug. 1991, burned Mar. 1992
1	Slash/Burn	1994-96
2	Harvest	1994-96
3	Harvest	1994-96
4	Harvest	1994-96
6	Harvest	1994-96
9	Slash	Slashed summer 1993
10	Harvest	1994-96
11/62*	Slash/Burn	Slashed summer 1993
12	Harvest	1994-96
14	Harvest	1994-96
15	Harvest	1994-96
16	Slash	1994-96
17	Harvest	1994-96
18	Slash/Burn	Slashed summer 1993
21	Slash/Burn	Slashed summer 1993
22	Slash/Burn	Slashed summer 1993
23	Harvest	1994-96
24	Harvest	1994-96
25	Harvest	1994-96

Continued

Unit	Treatment	Status
26	Harvest	1994-96
27	Slash/Burn	Slashed fall 1993
28	Harvest	Cut summer 1993
29	Slash/Burn	Slashed fall 1993
31	Slash	Slashed summer 1991
33	Slash	Slashed summer 1991
34	Harvest	Cut summer 1993
35	Slash	Slashed summer 1991
36	Harvest	Cut summer 1993
37	Slash	Slashed summer 1991
38	Harvest	Cut summer 1993
39	Harvest	Deferred to next decade
42	Harvest	Cut summer 1993
44	Harvest	Cut summer 1993
47	Harvest	Cut summers 1992, 1993
48	Harvest	Cut summer 1993
49	Slash	Slashed summer 1993
50	Harvest	Cut summer 1993
51	Harvest	Cut summer 1992, burned spring 1993
52	Harvest	Cut summer 1992, burned spring 1993
53	Harvest	Cut summer 1993
54	Harvest	Cut summer 1993
55	Harvest	To be finished by 08/01/94
56	Harvest	Deferred to next decade
57	Slash/Burn	1994-96
58	Harvest	Cut summer 1993
60	Harvest	Cut summer 1993
61	Harvest	Cut summer 1993
63	Pres. Burn	Burned Mar. 1993
64	Harvest	Cut summer 1993

Continued

Unit	Treatment	Status
66	Harvest	Cut summer 1993
69	Harvest	Cut summer 1993
70	Harvest	Cut summer 1993
71	Harvest	Cut summer 1993
82(B)	Harvest	1994-96
83(C)	Harvest	Cut summer 1993
85(E)	Harvest	Cut summer 1993

*Units 11 and 62 were combined into one treatment area.